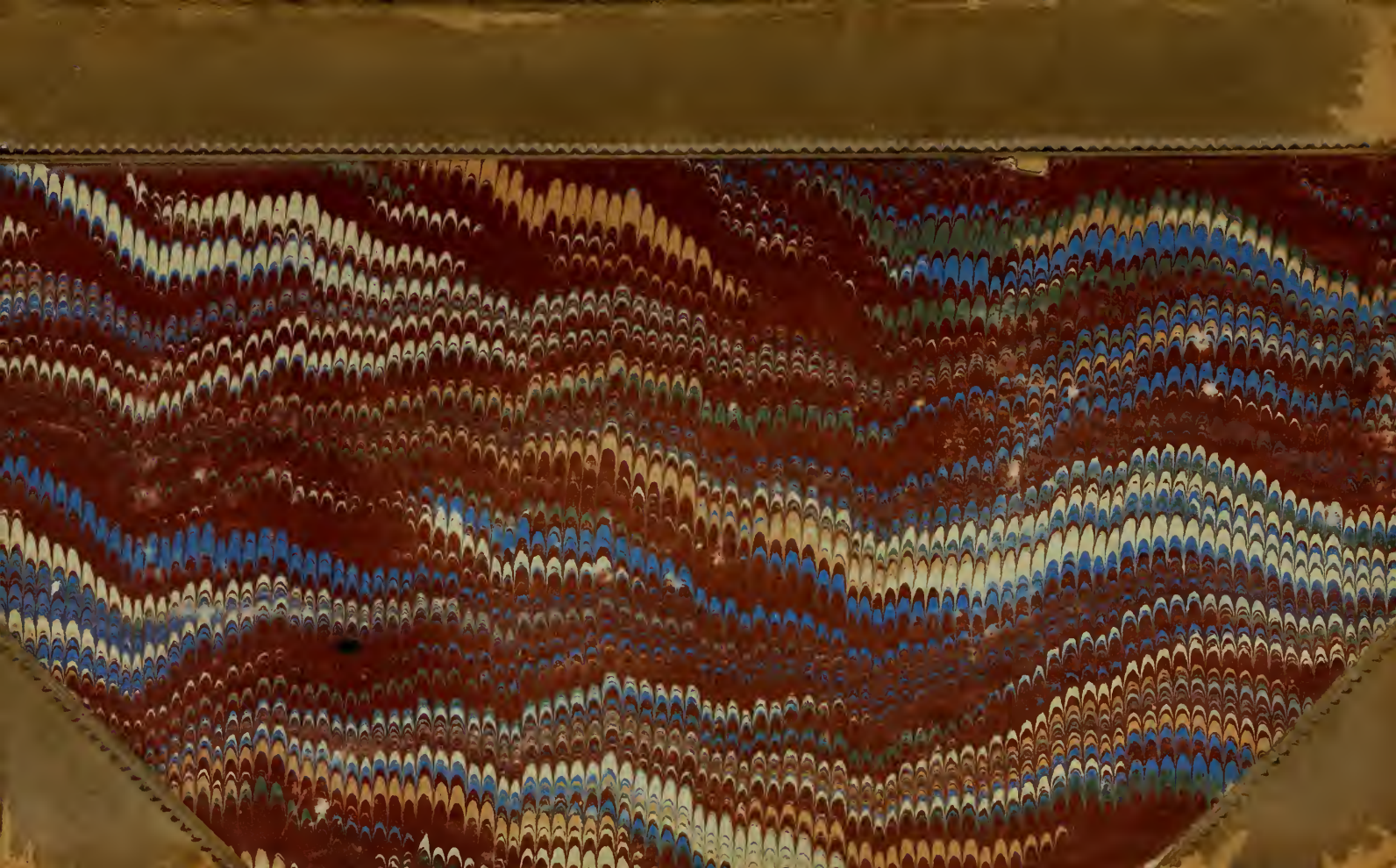

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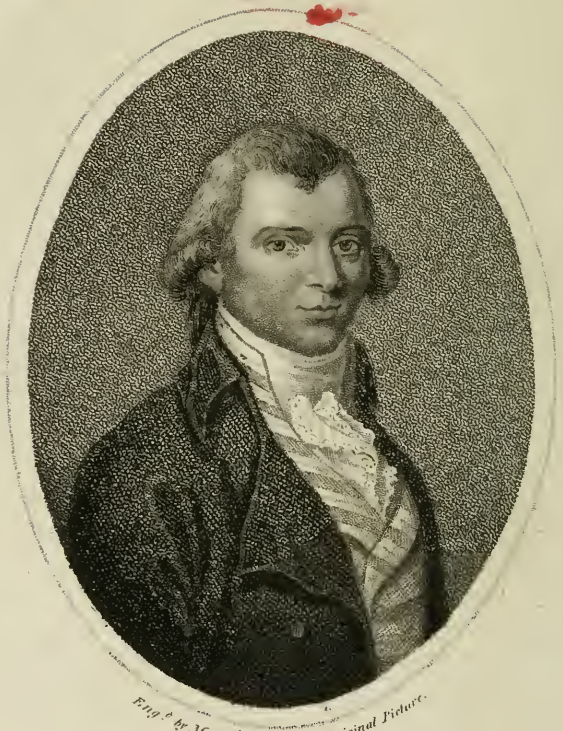

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PHILOSOPHICAL MAGAZINE:

COMPREHENDING

THE VARIOUS BRANCHES OF SCIENCE,

THE LIBERAL AND FINE ARTS,

AGRICULTURE, MANUFACTURES,

AND

COMMERCE.

BY ALEXANDER TILLOCH,

MEMBER OF THE LONDON PHILOSOPHICAL SOCIETY, ETC. ETC.

"Nec aranearum ſane textus ideo melior, quia ex ſe fila gignunt. Nec noſter vilior quia ex alienis libamus ut apes." JUST. LIPS. *Monit. Polit.* lib. i. cap. 1.

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HAVING ſelected a parcel of well-prepared Stourbridge clay crucibles, with covers exactly fitting, I proceeded to make the following experiments upon the quantity of charcoal which forms crude iron and ſteel; firſt premiſing that both crucible and cover were brought to a bright red heat before the ſubſtances acted upon were introduced. This was done with the greateſt poſſible caution, to avoid volatilizing any part of the charcoal, and rendering the reſult inaccurate. From the approximation of theſe reſults in repeating moſt of theſe experiments, I found that no material difference had occurred.

		Grains.
Exp. I. Swediſh bar iron - -		885
Charcoal $\frac{1}{2}$, or - - grs.	442	
This mixture was expoſed for half an hour, and a perfect button of ſupercarbonated crude iron was obtained. Along with the metal was found of intenſely black charcoal not taken up -	290	
Charcoal diſappeared, equal to 34·4 per cent.	152	
The metallic button now obtained was found to weigh		928
Gained in weight by the combination, equal to $\frac{1}{20\frac{1}{2}}$ part of the original weight of the iron - -		43
Charcoal diſappeared - -		152
Total loſs in charcoal		109

* Communicated by the Author.

	Grains.
Collective weight of the iron and charcoal originally introduced - - - grs. 1327	
Iron obtained in the fusion - grs. 928	
Charcoal not taken up - 290	
1218	
Total loss in this experiment	109
Exp. II. Swedish bar iron - -	925
Charcoal $\frac{1}{4}$th part, or - grs. 231$\frac{1}{4}$	
This mixture, after a similar exposure, was completely fused. When cold, the crucible was found to contain of very fine charcoal -	125$\frac{1}{4}$
Charcoal disappeared in the fusion, equal to 45 per cent. - - - -	106
The metallic button was richly carbonated, and weighed	972
Gained in weight by the union of charcoal, equal to $\frac{1}{19\frac{9}{10}}$th part of the original weight of the iron, -	47
Charcoal disappeared - - -	106
Lost in fusion	59
Collective weight of iron and charcoal originally introduced - - - grs. 1156$\frac{1}{4}$	
Iron obtained in the fusion grs. 972	
Charcoal not taken up - 125$\frac{1}{4}$	
1097	
Total loss in this experiment	59
Exp. III. Swedish bar iron - -	915
Charcoal $\frac{1}{7}$th, or - grs. 152	
This mixture was subjected to a similar heat, and a perfect fusion effected. There was found of charcoal not taken up - -	65
Charcoal disappeared, equal to 57 per cent.	87
The metallic button resembled the produce of No. I. and II., and weighed - - -	960
Gained by the fusion, equal to $\frac{1}{20\frac{3}{10}}$th part the first weight of the iron - - -	45
Charcoal disappeared - -	87
Lost in the fusion	42

Collective

	Grs.	Grs.
Collective weight of the iron and charcoal uſed	1067	
Iron obtained - - grs. 960		
Charcoal remaining - - 65		
	1025	
Total loſs in this experiment		42
Exp. IV. Swediſh bar iron - - -		977
Charcoal $\frac{1}{7}$th, or - grs. 122		
This mixture entered into fuſion in nearly the ſame time as the former. There was found on the ſurface of the metal a portion of very beautiful carbon, which weighed - -	40	
Loſt of charcoal in fuſion, equal to $67\frac{2}{10}$ths per cent. - - -	82	
The metallic button obtained in this experiment was ſuperbly carbonated, and apparently formed an entire maſs of carburet. It weighed - -		1020
Gained in weight by the union of carbon, equal to $22\frac{1}{2}$th part the firſt weight of the iron - -		43
Charcoal diſappeared - -		82
Loſt in the fuſion		39
Original weight of the mixture - grs. 1099		
Iron obtained - grs. 1020		
Charcoal remaining - 40		
	1060	
Total loſs in this experiment		39
Exp. V. Swediſh bar iron - -		1125
Charcoal $\frac{1}{9}$th, or - grs. 122		
From this fuſion was obtained a ſupercarbonated button of crude iron, upon the ſurface of which was found of fine charcoal - -	25	
Loſt of charcoal, equal to 80 per cent.	97	
Compared with the former reſults, the metal now obtained was inferior in point of carbonation. Its ſurface was ſmooth, and of a dull lead colour; entirely free from the uſual ſhining ſpecks of carburet which very rich crude iron contains upon its ſurface. It weighed - - - -		1168

	Grains.
Gained in fuſion, equal to $\frac{1}{20}$th part the weight of iron employed - - -	43
Charcoal diſappeared - -	97
Loſs in the fuſion	54
Collective weight of the mixture - grs. 1247	
Weight of metallic button - grs. 1168	
Charcoal not taken up - - 25	
1193	
Total loſs in this experiment	54

Exp. VI. Swediſh iron - - - 880
Charcoal $\frac{1}{12}$th, or - grs. 73

This was ſufficiently heated to produce fuſion. When cold, there was found upon the ſurface of the metal a portion of very black charcoal weighing - - - 12

Loſt in the fuſion, equal to $83\frac{1}{2}$ per cent.	61
The metallic button poſſeſſed a uniformly ſmooth ſurface, partially covered with carburet, and weighed	920
Gained by the combination of charcoal, equal to $\frac{1}{22}$d part - - - -	40
Collective weight of the mixture originally introduced - - - grs. 953	
Charcoal not taken up - grs. 12	
Iron obtained - 920	
932	
Loſt in the fuſion	21
Charcoal diſappeared - grs. 61	
Iron gained in weight - - 40	
Total loſs in this experiment	21

From the reſults of theſe experiments it becomes obvious that bar iron may be converted into the fineſt qualities of crude iron by the addition of any portion of charcoal from $\frac{1}{2}$ to $\frac{1}{12}$th part its weight: that in paſſing from the malleable to the carbonated crude ſtate, it uniformly gains in weight by a combination of carbonaceous matter equal to $\frac{1}{20\frac{1}{2}}$, $\frac{1}{19\frac{9}{10}}$th, $\frac{1}{20\frac{3}{10}}$th, $\frac{1}{22\frac{4}{10}}$th, $\frac{1}{26}$th, $\frac{1}{22\frac{1}{2}}$d: average $\frac{1}{21\frac{8}{10}}$th part its own weight.

It is here again worthy of remark, that in all theſe experiments

riments with open veſſels, a portion of charcoal diſappeared always in proportion to the quantity introduced, and not analogous to the quantity of iron.

Diſappeared of Charcoal.		Iron gained.
When $\frac{1}{2}$ was uſed, 34·4 per cent.	-	$\frac{1}{20\frac{1}{2}}$th part.
When $\frac{1}{3}$th was uſed, 45 per cent.	-	$\frac{1}{19\frac{5}{10}}$th part.
When $\frac{1}{6}$th was uſed, 57 per cent.	-	$\frac{1}{20\frac{3}{10}}$th part.
When $\frac{1}{8}$th was uſed, 67·2 per cent.	-	$\frac{1}{22\frac{4}{10}}$th part.
When $\frac{1}{9}$th was uſed, 80 per cent.	-	$\frac{1}{26}$th part.
When $\frac{1}{12}$th was uſed, 83·5 per cent.	-	$\frac{1}{22}$d part.

Upon the whole, if the reſults of theſe ſix experiments, performed in open veſſels, are compared with the three firſt detailed in laſt communication, where a ſimilar quality of crude iron was obtained in veſſels perfectly cloſe, no material difference will be found. They mutually ſupport each other, as to the quantity of carbon neceſſary to form crude iron, while they ſtill leave in doubt the cauſe of the diſappearance of the charcoal in cloſe veſſels. In the caſe of open veſſels, it is highly probable that a conſiderable portion of the charcoal is deſtroyed before the heat of the furnace is ſufficiently ſtrong to lute the cover of the crucible.

This ſtill, however, leaves unexplained, why, in experiment I. a loſs of 152 grains of charcoal is ſuſtained; while in No. VI. the original quantity introduced did not amount to half that quantity, yet 12 grains of the latter was found entire reſting upon the ſurface of the reduced metal. The thickneſs and capacity of the crucible in both caſes, and, indeed, all theſe experiments, were nearly alike.

The fact of malleable iron being convertible into the moſt carbonated ſtate of crude iron, either in cloſe or open veſſels, where a portion of the carbonaceous matter was found repoſing upon the ſurface of the newly-changed metal, creates ſome doubts as to the exiſtence of oxygen in crude iron. If it is admitted that bar iron is deſtitute of oxygen, which it is highly probable is the caſe; if a portion of this iron is introduced and fuſed along with a portion of carbonaceous matter in a veſſel impervious to air, which veſſel is found, when cold, to be more than half filled with charcoal, protecting a

metallic button of crude iron below; it is with the greateſt difficulty we can admit of the preſence of oxygen in the metallic maſs. It may be urged, that charcoal, conſidered as an oxide of carbon, might impart a portion of oxygen to the metal. This muſt ſuppoſe, however, a continual action and reaction of affinity, wherein it is preſumable the carbon would finally prevail, and carry off the oxygen. I conceive it more juſt to ſuppoſe, that what quantity of oxygen was contained in the charcoal, would be diſcharged by the latter deoxydating itſelf analogous to its ſuperior affinity, rather than combining with the iron.

It is a fact well known amongſt manufacturers, that caſt iron of a ſilvery white fracture may be ſaturated to exceſs with carbonaceous matter ſimply by cementing it in contact with charcoal. In this proceſs it acquires a ſoft gray fracture, eaſily reducible by the file. If this caſt iron originally contained oxygen, a long cementation in contact with charcoal, moſt likely, would deprive it of this; yet we find it ſtill poſſeſſed of all the properties of caſt iron. From this we ſhould be apt to conclude that oxygen at leaſt is not neceſſary to the production of crude iron.

Again, in the proceſs of cementation bar iron is firſt changed, by a comparatively ſmall doſe of carbon, into ſteel. If this ſteel, by accident or intention, be continued ſomewhat longer in the furnace under an increaſed temperature, an exceſs of affinity is eſtabliſhed betwixt the metal and the charcoal without the preſence of a third principle: the ſteel becomes gradually more and more carbonated: it changes its fracture of granulation, if I may be allowed the term, from that peculiar to bliſtered ſteel, through all thoſe breaks peculiar to the reſpective qualities of crude iron; and may at laſt paſs into the ſtate of a carburet of iron totally different in its properties and appearance from either ſteel or crude iron. This proceſs may be carried on to the utter excluſion of atmoſpheric air; and here, if the proceſs is ſtopped in its proper ſtages, will be found all the various qualities of crude iron formed without perfect fuſion, where we cannot conceive oxygen to have exiſted.

I am aware of adducing circumſtances from theſe experiments, at variance with the preſent received opinions upon the conſtituent parts of caſt iron, and alſo in oppoſition to principles which I have formerly laid down. I wiſh not the preſent hints to be conſidered as aſſertions. As irreconcileable in ſome degree with former opinions, I wiſh they may lead to an ample inveſtigation of the ſubject. The diſtinction hitherto made betwixt crude iron and ſteel, particularly

by

by the French chemiſts, has been, that crude iron was the metal imperfectly reduced, but that the latter was iron perfectly reduced, combined with a ſmall portion of carbon. The fact, however, of malleable iron paſſing into the ſtate of fine crude iron without the contact of an oxygenous body, puts it upon a ſimilar footing with ſteel, only altered by a greater comparative quantity of carbon. This reduces us to the neceſſity of drawing one of the two following concluſions: that ſteel is, equally as crude iron, a combination of iron, carbon, and oxygen; or, that crude iron differs from ſteel only in the proportion of the carbon with which it is ſaturated.—The communication which ſhall be forwarded for the next number of the Magazine, will, I hope, leave little doubt upon this head.

II. *Memoir on Gluten.* *By* CHARLES LOUIS CADET, *of the College of Pharmacy, Paris* *.

THE chemiſts who have made reſearches in regard to the glutinous principle of vegetables, and particularly that of wheat, have found no ſolvents of that matter but weak acids and cauſtic alkalies. When the gluten indeed is freſh, theſe two kinds of re-agents only have the power of diſſolving it; but, however, by altering it, that is to ſay, by taking from it the agglutinative property. Theſe ſolutions have not yet afforded any application uſeful to the arts; and gluten itſelf, in its natural ſtate, has been employed only to cement broken china; but, when gluten has experienced a commencement of fermentation in damp air, its ſolubility is increaſed, as I proved by the following experiments:

I put into an earthen veſſel about three hectogrammes of gluten extracted from wheat in the uſual manner. This veſſel was placed in a damp hot-bed: at the end of ſeven or eight days the ſurface of the gluten became brown, and covered with white *byſſus* ſimilar to that which vegetates on ripening fruit. I removed this byſſus, and continued to obſerve the alteration of the gluten: on the fifteenth day the maſs appeared to increaſe in volume; ſome gaſeous bubbles raiſed up the ſurface, and an acetous odour manifeſted itſelf: on preſſing the gluten a little, there iſſued from it a milky acid liquor. On the twenty-fifth day the odour was ſtronger, but always aceſcent; and, on removing the ſort of ſkin which was formed on the paſte, the ſoftened gluten had become

* From the *Annales de Chimie*, No. 123.

viſcid,

viſcid, and had a great reſemblance to grayiſh white glue. In this ſtate I employed it for making the following trials:

I triturated four grammes of this glue in a glaſs mortar, after having poured over it ſome drops of alcohol. The gluten appeared to me to diſſolve. I gradually added alcohol, and thus brought the gluten to the liquid conſiſtence of thick ſyrup. I increaſed the quantity of alcohol, hoping to obtain a complete ſolution; but when the quantity of alcohol was nearly double that of the gluten, the latter ſuddenly ſeparated, reappeared under its firſt form, and it was impoſſible for me to charge the ſolution more. I filtered the alcohol, which paſſed with a ſlight amber colour.

To aſcertain whether this ſolution contained much gluten, I poured over it an equal volume of diſtilled water: the mixture immediately became white like an emulſion, and ſuffered to be ſlowly depoſited an abundant precipitate, which had the appearance of a fecula, but which, when more cloſely examined, appeared to be gluten very much divided. The alcoholic ſolution of gluten, when left for fifteen months in a flaſk ſtopped with cork, depoſited a part of the gluten in the form of a white, thick, elaſtic membrane, which ſhrinked when expoſed to heat, burned in the manner of animal matters, and had a great reſemblance to white caout-chouc formed from the juice of the heræa.

I evaporated, at a gentle heat, the remainder of the ſolution, and obtained dry gluten, brittle, yellowiſh at the ſurface, and ſhining like beautiful varniſh.

It reſults from theſe experiments, that the gluten which has experienced acid fermentation is in a great part ſoluble in alcohol. This effect is owing, no doubt, to the acetous acid which is formed by the fermentation, and which breaks the force of the aggregation of the gluten; for I kneaded the freſh gluten a long time in alcohol without being able to diſſolve a ſenſible quantity. This chemical fact is of very little importance in itſelf, but it ſuggeſts ſome uſeful applications.

Having brought the fermented gluten to the conſiſtence of ſyrup by means of alcohol, I ſpread this thick ſolution with a bruſh over different bodies, ſuch as wood, glaſs, and paper. It dried ſpeedily, and formed a tranſparent varniſh, which adhered ſtrongly and did not become ſcaly. Paper varniſhed in this manner might be ſubſtituted for that brought from England under the name of *papier à cautere* *.

The fermented gluten, diluted in acetous acid, furniſhed a

* We imagine the author means that kind of brown paper in which ironmongery goods are uſually lapped up.—EDIT.

varniſh

varnish nearly similar; but that obtained by an alcoholic solution of gluten evaporated to the consistence of syrup is preferable.

I employed this varnish to preserve several objects of natural history from the influence of damp air. As it possesses a certain degree of elasticity, I consider it to be equally proper for varnishing anatomical preparations. It is more convenient than fresh glue for cementing broken porcelain.

This first trial necessarily conducted to the idea of employing the solution of gluten as an excipient of different colouring matters. I mixed then a certain quantity of glutinous varnish with white oxide of lead, minium, indigo, and carmine, and obtained colours more or less bound, but which were all easily extended with the pencil, which adhered strongly even to glass, dried speedily, and had no disagreeable odour. I remarked that the vegetable colours mixed with greater facility than the oxides.

As I formed these mixtures in mortars of glass or agate, I did not obtain colours so homogeneous as if I had ground them on porphyry. When these colours are well prepared, that is to say, when the proportion of the colouring matter does not exceed that of the gluten, the painting may be washed without any fear of altering it, unless rude friction be employed.

This gluten presents then to artists a new kind of painting, less solid, perhaps, than oil painting, which experience will determine, but perhaps less susceptible of changing by the action of air and light. It would be attended with two great advantages in printing figures or paintings—that of speedily drying, and of not exposing the persons who inhabit apartments newly painted to any of those accidents frequently occasioned by oil painting.

As the price of alcohol might render this painting dear, I tried to prepare colours with glutinous varnish made by means of acetous acid; but I was never able to mix it with any oxide: the gluten immediately separated itself, and was precipitated in a more solid form than it had before its solution: it is therefore necessary to employ alcohol; but the common alcoholic products, sold commonly in the shops under the name of *varnishers' spirit of wine*, may be employed.

If this painting were adopted, it would be necessary that the gluten should be found in sufficient quantity and at a low price. It might be furnished by the starch-makers, if they substituted for their method of operation a process analogous to that employed in the laboratories for separating the starch from gluten. It would be easy to construct a machine to tritu-

rate the paſte under a ſtream of water, and to prepare a gluten entirely freed from any amylaceous principle. But before this object can be carried into execution, it will be neceſſary that various trials ſhould be made by artiſts to aſcertain whether the glutinous ſolution has the properties requiſite for painting, or at leaſt for varniſhing.

Chemiſts may, however, employ it in the mean time as luting. I mixed with fermented gluten diluted in alcohol a certain quantity of quicklime: ammonia and caloric were diſengaged, and the mixture aſſumed a ſoft conſiſtence. With this paſte I luted ſeveral veſſels, placed over them bands of linen dipped in the ſolution of gluten, and beſprinkled them with quicklime: they ſoon adhered with ſuch force that I think this luting preferable to that prepared with the whites of eggs.

It appears to me to reſult from theſe exeperiments:

1ſt, That freſh gluten is inſoluble in alcohol.

2d, That it becomes ſoluble when it has undergone acid fermentation.

3d, That the alcoholic ſolution of gluten is precipitated by water.

4th, That this ſolution, evaporated to the conſiſtence of ſyrup, furniſhes a varniſh which may be employed in the arts.

5th, That fermented gluten diluted in alcohol becomes an excipient of colouring matters, and makes them adhere to the ſmootheſt bodies.

6th, That vegetable colouring ſubſtances combine with gluten better than others.

7th, That painting where gluten has been uſed dries very ſoon, has no noxious odour, and may be waſhed.

8th, That a very ſtrong and tenacious luting may be made with gluten and lime.

III. *Obſervations on the Acetic and Acetous Acids.* By C. Darracq*.

THE numerous opinions of chemiſts on the difference between the acetic and acetous acids have induced me to make a few reſearches on the ſubject. But before I give an account of my experiments I ſhall mention a few of thoſe of the modern chemiſts, and alſo the concluſions which they have drawn from them.

C. Adet read a memoir in the Inſtitute, on the 11th Ther-

* From the *Annales de Chimie*, No. 122.

midor,

midor, year 6, on the acetic acid, publiſhed in the *Annales de Chimie* of the ſame year. By very intereſting and well-performed experiments C. Adet endeavoured to prove that there did not exiſt two acids of vinegar, and he concluded from them, that the acetous acid is conſtantly at the higheſt degree of oxygenation; that it is conſequently in the ſtate of acetic acid; and, in the laſt place, that the difference which exiſts between the acetous and acetic acid ſeems to depend on the leſs quantity of water contained in the latter, and not on a greater proportion of oxygen, as before believed. I ſhall not deſcribe his experiments, as they are too numerous; I ſhall only obſerve that they are very exact.

In the month of Brumaire, year 7, C. Chaptal publiſhed his obſervations on the ſame ſubject *. By new experiments he combats not thoſe of C. Adet, but the conſequences he has deduced from them. He however does not conſider the acetic acid as more oxygenated than the acetous acid, but only as containing leſs carbon; he mentions ſeveral experiments which ſeem to ſupport his theory, and particularly the diſtillation of acetite of copper. This celebrated chemiſt ſays, that when this ſalt is diſtilled the acetous acid is decarbonized; a part of this carbon combines itſelf with the oxygen of the oxide of the copper, and eſcapes in carbonic acid; while the other remains in its natural ſtate in the retort with the metallic oxide, and while the acetous acid, thus deprived of a portion of its carbon, paſſes into the receiver in the ſtate of acetic acid. A number of other experiments are quoted in ſupport of this reaſoning; but I ſhall not deſcribe them as they are printed, I ſhall only deſcribe thoſe made by myſelf.

To aſcertain whether the acetic acid was more oxygenated than the acetous acid, I repeated ſome of C. Adet's experiments, which I found to be perfectly correct; but it would be uſeleſs to deſcribe them, ſince all thoſe chemiſts acquainted with them are agreed in regard to the oxygenation of the acetic and acetous acids; but it will not be improper, perhaps, to mention ſome new ones which ſeem to ſupport this theory.

As the two acids in queſtion differ a great deal by their concentration, I brought them before I employed them to the ſame degree; and for this purpoſe employed the ſpecific gravity of pure acetous acid, which was 1·007: on the other hand, I mixed with the acetic acid a ſufficient quantity of diſtilled water until its denſity was equal to that of 1·007, or of acetous acid. In this ſtate there is very little difference

* *Annales de Chimie*, vol. xxviii. p. 113.

between

between theſe two acids, only that the acetic acid emits a very ſlight empyreumatic odour.

I took 2000 parts of acetous acid, which I put into a retort with 500 parts of nitric acid. The apparatus being properly diſpoſed for collecting the liquid and gaſeous products, the mixture was carried to the ſtate of ebullition, and continued till the 2000 parts nearly of the acetous acid employed were diſtilled. No gas paſſed during the operation, and the product, when examined, ſhowed no mark of alteration, its ſpecific gravity being equal to that of the acid employed, that is to ſay, 1·007. When combined with oxide of lead, I obtained, by proper evaporation, a cryſtallized ſalt, which was found to be common acetite of lead: it appears to be nearly certain that the acetous acid experienced no change during this operation; its odour was neither ſtronger nor more penetrating than that of the acetous acid employed, and its ſavour was neither ſtronger nor more pungent.

By a ſecond experiment I again endeavoured to oxygenate, if poſſible, the acetous acid. For this purpoſe I prepared what was neceſſary to obtain oxygenated muriatic acid gas, and the apparatus being arranged the gas was received in a flaſk containing acetous acid: after more than a ſufficient quantity had paſſed over, the apparatus was unluted, and the acid collected was carefully examined.

As the odour of the oxygenated muriatic acid conceals that of the acetous acid, the product was placed in a capſule, and expoſed to a gentle heat. When the greater part of the oxygenated muriatic acid had been deſtroyed, the acetous acid exhibited no ſenſible change; its ſavour only appeared to be ſtronger; on account, no doubt, of the muriatic acid which it contained. When combined, like that of the firſt experiment, with oxide of lead, I obtained a needle-formed cryſtallization of muriate of lead; and then a ſecond ſalt, perfectly ſimilar to common acetite of lead, and to that of the firſt experiment. I am therefore of opinion, eſpecially when I call to mind the numerous experiments of C. Adet, that we may aſſert that there do not exiſt two degrees of oxygenation in vinegar. Other experiments would be ſuperfluous, ſince, as I have already ſaid, chemiſts are agreed on this point; but that on which opinions differ, is in regard to the different proportions of the carbon: the experiments I made on this ſubject I ſhall here deſcribe.

Exp. I. After having brought the acetic and acetous acids, as in the former caſe, to the ſame degree of ſpecific gravity, I ſaturated a given quantity of pure and cryſtallized carbonate of

of potaſh with the two acids. As it is very difficult to aſcertain with certainty the true point of ſaturation, I ſhall not ſpeak of the reſpective quantities employed; they appeared to me to be nearly equal. When I had evaporated theſe two ſalts to dryneſs, they both preſented themſelves under the form of laminæ, of a ſavour equally pungent and hot, and, at laſt, urinous and alkaline; in a word, no difference could be obſerved between them.

For the preſent, I ſhall call the one *acetite of potaſh*, and that made with acetic acid *acetate*. I took 576 parts of each of theſe ſalts, which had been evaporated and brought as far as poſſible to the ſame degree of deſiccation, and put them into two glaſs retorts. They were expoſed in a furnace to an equal heat, and during the diſtillation the ſame phænomena were obſerved. Some drops of a liquor ſlightly coloured, and of an acrid ſavour, paſſed over into the two receivers. This liquor increaſed in a ſenſible manner till the end of the diſtillation; and after expoſure to a ſtrong heat there remained in the two retorts a carbonaceous matter, which was treated with boiling water in order to remove by waſhing all the alkaline part mixed with the carbon. Being ſeparately filtered, there remained in the filters two light reſiduums known to be charcoal. The two filters which contained them were placed in a ſtove for 24 hours, and conſequently were dried nearly in an equal degree. In this ſtate the two portions of charcoal being weighed, that of the acetite weighed $22\frac{1}{2}$ parts, while that of the acetate weighed only 22. It is ſeen by this reſult that the difference is exceedingly ſmall, and that there is reaſon to believe that the degree of the deſiccation of the reſiduums, or of the ſalts employed, may be the cauſe of the ſmall quantity of charcoal which the acetite furniſhed more than the acetate.

Exp. II. I ſaturated cryſtallized carbonate of ſoda with equal quantities of the acetous and acetic acid, and, by repeated evaporations, I obtained the two ſalts cryſtallized in the ſame manner: they exhibited ſtriated priſms, among which I remarked ſome hexaedral; their ſavour was equally pungent and bitter, and their colour white and brilliant.

Theſe two ſalts, well cryſtallized, were dried in an equal degree between filtering paper in a place ſlightly heated, where they were left till the paper was no longer moiſtened. I then took, as in the former experiment, 576 parts of acetite and acetate of ſoda, and put them into two retorts: theſe two ſalts, expoſed to a graduated heat, firſt became liquid: in proportion as I augmented the heat they became black, and there paſſed over into the two receivers liquors ſlightly coloured,

loured, in which floated a kind of oil, the quantities of which were apparently equal. After ſtrongly urging the fire, there remained in the two retorts black reſiduums, which I treated with boiling water as in the firſt experiment. The charcoals remaining in the filters were dried in a ſtove, and then weighed: that produced by the acetate of ſoda weighed eight parts, and that produced by the acetite eight parts and a half. Theſe two reſiduums when examined were found to be charcoal, ſimilar to that obtained by the acetite and acetate of potaſh. This experiment, which on account of the cryſtallization of the ſalts ought to be conſidered as correct, ſince the proportions of the conſtituent parts of the ſalts were found to be the ſame, explains what we have already announced, why the acetite of potaſh gave a little more charcoal than the acetate. There is reaſon, no doubt, to believe that it aroſe from the greater or leſs deſiccation of the ſalts, and the manner in which they were burnt, ſince in the ſecond experiment I found not only the ſame quantity of charcoal in the reſiduum of the acetate of ſoda, but even a ſmall quantity more than in the acetite.

Exp. III. Being perſuaded, by the reſults of theſe two experiments, that the acetous was not more carbonized than the acetic acid, I made as a new proof the following experiment: I put equal parts of ſulphate of copper and acetite of lead, both cryſtallized, pulverized, and mixed, into a retort, which was placed in a furnace over an open fire, joined to the retort an adapter and a receiver, and to the latter a bent tube to collect the elaſtic fluids. At a very gentle heat there paſſed over a white liquid, which increaſed without changing its colour: the fire being continued a conſiderable time that I might obtain all the acetic acid, no other gas paſſed over but a part of the air of the veſſels; the heat was continued till the glaſs retort began to enter into fuſion, upon which it was taken from the fire. There remained a reſiduum of a reddiſh yellow colour, the weight of which was equal to two-thirds that of the mixture employed: the liquid obtained had a perfect reſemblance to pure acetic acid, its weight was equal to a third of the quantities employed. A ſimilar experiment is deſcribed in the *Annales de Chimie* by C. Badolier; but its object, indeed, was different from that of the preſent one, it was publiſhed merely for the purpoſe of giving a ſimple and economical proceſs for obtaining radical vinegar. The author, however, obſerves very juſtly that no carbonic acid was diſengaged, as was the caſe in my operation; nor did I obtain a ſingle atom of acid gas. I endeavoured alſo to diſcover whether any carbon remained in the reſiduum; a rigorous examination

examination ſhowed that none exiſted. This experiment with that above deſcribed ſeems evidently to prove that acetous acid is not more carbonized than acetic acid; for it is certain that, if it contained more, the exceſs above that neceſſary to conſtitute the acetic acid produced would have remained in the reſiduum.

However concluſive my experiments might be in my own opinion, I ought not to loſe ſight of that of Chaptal, ſince it is deſcribed in the obſervations I have quoted. Having diſtilled then, with a proper apparatus, 576 parts cryſtallized acetite of copper, there paſſed over into the receiver a white liquor, which was coloured by the progreſs of the diſtillation, and which became green by the copper: this liquid was acetic acid. Before the diſtillation there were diſengaged 65 inches of a gaſeous fluid, which, when examined, was found to be a mixture of carbonic acid gas and hydrogen gas: the reſiduum, of a blackiſh brown colour, being treated with muriatic acid, the latter diſſolved the oxide of copper, and left a powder ſlightly black, which was collected on a filter: this black matter, when edulcorated, dried, and then ſubjected to chemical examination, was found to be charcoal, the weight of which was 22 parts. As this reſult was perfectly ſimilar to that deſcribed by the chemiſts, it was neceſſary to examine whether the conſequences they deduced from it were very exact; for it may be aſked, why the acetous acid was decarbonized under theſe circumſtances alone, and not in that of which I here give an account. Preſuming that I ſhould find a ſolution of this queſtion by means of comparative experiments, I made the following:

I prepared acetate of copper by diſſolving oxide of copper in acetic acid diluted with water, and by proper evaporation I obtained a ſalt cryſtallized in octaedra. Of this ſalt, when dried to the ſame degree as the acetite of copper, I introduced 576 parts in a retort, and expoſed it to heat: it exhibited exactly the ſame phænomena as the acetite. I obtained nearly equal quantities of hydrogen gas and carbonic acid. The liquid, when collected in the receiver, had the ſame colour; when examined comparatively with that produced by the acetite, it was impoſſible to find any difference between them. The reſiduum, of a blackiſh brown colour, was treated with muriatic acid, which diſſolved the oxide of copper, and left a black matter, which floated on the liquid. This matter, ſeparated by means of the filter, and dried on a ſtove, being ſubjected to analyſis, was found to be charcoal perfectly ſimilar to that of the preceding experiment: it had abſo-

lutely the ſame weight as that produced by the diſtillation of the acetite of copper; that is to ſay, it weighed 22 parts.

From this reſult it is evident that the charcoal obtained by diſtilling acetite of copper does not ariſe from the acetous acid containing more than the acetic acid, ſince the latter, when ſubjected to the ſame operation, gives an equal quantity. In my opinion, that produced in theſe operations does not ariſe from a portion of the acid decompoſed, the quantities of which ought to vary according to the progreſs of the decompoſition. Experience authorizes me to believe that the difference which may exiſt between the two acids in queſtion does not depend either on the proportions of the oxygen or of the charcoal. I ſuperintended ſome trials, not on the conſtituent principles of vinegar, but on vinegar itſelf, and the kind of mucilage with which it is accompanied. Before I deſcribe this labour I muſt not forget to obſerve that C. Chaptal furniſhed me with the idea by his obſervations on the acetic and acetous acids. He ſays on this ſubject, that the acid of vinegar may be conſidered as exiſting primitively in a ſtate almoſt ſaponaceous; which diminiſhes its action, and weakens its properties.

After having aſcertained, by ſome experiments, the exiſtence of this extractive or mucilaginous principle, I endeavoured to ſeparate it. Diſtillation as well as filtration were found to be imperfect means: my vinegar always contained mucilage: it remained nearly the ſame. However, by combining it, after diſtillation, with alkaline baſes, it depoſited very little of that flaky matter called *extractive matter*. Having not forgot, during theſe reſearches, the opinion of C. Adet, who ſays that the quantity of water might occaſion the difference between the acetous and acetic acids, comparing the obſervations of theſe two chemiſts, I made ſome experiments, which appear to me to be intereſting; but I ſhall deſcribe that only which appeared to me to be moſt concluſive.

Entertaining the idea that there was no difference between the acetous acid and the acetic, but a larger quantity of water, and an extractive or mucilaginous matter, I endeavoured to find the proper means of ſeparating the former from it, and bringing it to the ſtate of acetic acid. For this purpoſe, I prepared muriate of lime, which I ſtrongly calcined. After reducing it to powder, I put it into a tubulated retort, and poured over it common acetous acid with an apparatus proper for receiving the products. The retort, which was on a ſand-bath, being expoſed to a gentle heat, the matter immediately entered

entered into ebullition, on account of the heat produced by the calcareous ſalt in ſolidifying the major part of the water contained in the vinegar. During this diſtillation there paſſed over a clear liquor, which fell in ſtriæ on the ſides of the adaptor, and which was collected in a receiver. This liquor totally changed in appearance; had a ſtronger and more pungent ſavour than the acetous acid employed, and its odour was ſharper and more penetrating: one might have taken it for diluted radical vinegar. This product, when ſubjected to a ſecond diſtillation with dried muriate of lime, acquired a little more ſtrength: after a third and a fourth rectification, a tranſparent liquor was obtained, of an odour and ſavour very ſimilar to that of common acetic acid. During theſe rectifications, not an atom of charcoal was depoſited. To aſcertain whether the acid obtained, in loſing a great quantity of its water, had loſt alſo the mucilaginous matter which accompanied it, I ſaturated a portion with cryſtallized carbonate of potaſh: in vain did I add an exceſs of this ſalt, for nothing was precipitated; whereas common acetous acid, by a ſimilar ſaturation, precipitates a flaky matter, which is collected in the bottom of the veſſel employed.

Though the ſtrong and penetrating odour of the acetic acid obtained by the ſimple means above deſcribed was ſufficient to induce me to conclude that it was really ſimilar to that obtained from metallic acetites, I endeavoured to aſcertain this fact by a new experiment. For that purpoſe I took equal parts of this radical vinegar and of alcohol to try to make acetic ether: the attempt was not unſucceſsful; and, by Pelletier's proceſs, I obtained an ether perfectly agreeable, and having an exact reſemblance to the acetic ether found in laboratories. I muſt here obſerve, in ſpeaking of the acetic acid obtained by rectification alone with muriate of lime, that it is far more agreeable than the acetic acid produced, for example, by the diſtillation of metallic acetites; and eſpecially when they are diluted with water. The latter then aſſumes a diſagreeable empyreumatic odour, and an oily ſavour, ariſing from a portion of acetic acid which has been decompoſed by the heat, and which has given birth to a kind of oil which the acid retains in combination. The other, on the contrary, paſſes only to the ſtate of common acid of vinegar by preſerving an agreeable pungency. Before any concluſion can be drawn from the preceding reſults, I muſt not forget to mention an intereſting fact remarked by C. Pontier. This able chemiſt and mineralogiſt, who diſcovered the chromate of iron in France, ſent, about eight

months ago, to C. Vauquelin a flask containing a liquor obtained by the distillation of vinegar on a large scale. As C. Pontier was not ignorant that the first product of the distillation of the acetous acid is aqueous, he separated it from that which followed. After uniting several phlegms of the same kind, he was much astonished to find that these phlegms had a very agreeable aromatic odour: having discovered, by preliminary trials, the properties which gave this product a similarity to ethereal liquors, he rectified all the supposed phlegms, and by these means obtained a peculiar ether, which Vauquelin found to be acetic ether completely rectified.

From an identity so striking in the experiments above described, it is evident that there exists no difference between the constituent parts of the acetic and acetous acids; that the water, and mucilaginous or extractive matter, are the only two apparent differences observed in these two acids; and, consequently, that there exists only one acid of vinegar, which being at its maximum of oxygenation, ought, according to the chemical nomenclature, to be distinguished by the name of *acetic acid*. In future, therefore, there will not exist two different kinds of salts, either by the combination of distilled vinegar or of radical vinegar; they will hereafter be so many products, the names of which must be the same; and hence *acetates* will exist, and not *acetites*.

IV. *Description of a new Implement called a Cultivator. By Mr.* William Lester, *of Northampton**.

SIR,

As the health and luxuriance of corn depend, in a great measure, on the pulverization of the soil previous to the seed being sown, the Society of Arts will, I am persuaded, give every encouragement in their power to the introduction of any implement that promises an abridgement of labour; and as all tenacious soils are pulverized in the best manner in dry weather, when their particles are the most disjointed, and their contact broken, the propriety of taking the advantage of working them in that state will be obvious: and at the same time it follows, that an improved implement for the abridgement of labour would be a desirable thing in a climate like England, where the seasons are so uncertain.

* From the *Transactions of the Society for the Encouragement of Arts, &c.* vol. xix.—The Society's silver medal was awarded to Mr. Lester for this invention.

In working on a rough fallow, my cultivator ſhould be ſet at its greateſt expanſion, and contracted in proportion as the clods are reduced. I am confident that one man, a boy, and ſix horſes, will move as much land in a day, and as effectually, as ſix ploughs; I mean land in a fallow ſtate, that has been previouſly ploughed.

It will be requiſite in ſome ſtates of the ſoil to alter the breadth of the ſhares; but of this, I preſume, the farmer will always be a proper judge. By the expanſion and contraction of the cultivator, the points of the ſhares are, in a ſmall degree, moved out of the direct line; but this is ſo trifling, that it is no impediment to its working. I am, Sir,

Your moſt obedient ſervant,

Northampton. Feb. 10, 1801. WILLIAM LESTER.

Mr. C. Taylor.

A certificate from Mr. William Shaw, of Cotton End, near Northampton, accompanied this letter; in which he ſtates, that he had uſed Mr. Leſter's cultivator upon a turnip fallow laſt ſummer, and that he believes it to be a very uſeful implement for cultivating the land in a fallow ſtate, by its working or ſcuffling off ſeven acres per day, with ſix horſes. He adds, that, from its property of contracting and expanding, it is calculated to work the ſame land in a rough or fine ſtate, by which mean it unites the principles of two implements in one; and, by the index on the axis, it may be worked at any given depth required.

Deſcription of Mr. Leſter's Cultivator. (Plate I. fig. 1.)

A, the beam.

B B, the handles.

C C, a croſs bar of a ſemicircular form, containing a number of holes, which allow the two bars D D, to be placed nearer or further from each other.

D D, are two ſtrong bars, moveable at one end upon a pivot E, and extending from thence, in a triangular form, to the croſs bar C. In theſe bars are ſquare holes, which allow the ſhares F, placed therein, to be fixed to any height required.

The ſeven ſhares marked F, are ſhaped at their lower extremities like ſmall trowels: the upper parts of them are ſquare iron bars.

G G } are three iron wheels, on which the machine is
G, } moved; they may be raiſed or lowered at pleaſure.

H, the iron hook to which the ſwingle-tree and horſes are to be fixed.

When the machine is firſt employed on the land, the bars D D are expanded as much as poſſible. As the ſoil is more looſened, they are brought nearer to the centre: the ſhares then occupy a leſs ſpace, and the ſoil will conſequently be better pulverized.

V. *Deſcription of a newly invented Underſhot Water-wheel. By Mr.* J. Besant, *of Brompton**.

SIR,

I BEG leave to lay before the Society ſome obſervations reſpecting the common underſhot water-wheel, and to point out the ſuperiority of that of my invention.

1ſt, In common water-wheels more than half the water paſſes from the gate through the wheel, without giving it any aſſiſtance.

2dly, The floats coming out of the tail-water are reſiſted with almoſt the whole weight of the atmoſphere at the inſtant they leave the ſurface of the water.

3dly, The ſame quantity of water which paſſed between the floats at the head, muſt of courſe paſs between them at the tail, and conſequently impede the motion of the wheel.

In the water-wheel of my invention,

1ſt, No water can paſs but what acts, with all its force, on the extremity of the wheel.

2dly, The floats coming out of the water in an oblique direction, prevent the weight of the atmoſphere from taking any effect.

3dly, Although the new water-wheel is heavier than that on the old conſtruction, yet it runs lighter on its axis, the water having a tendency to float it.

4thly, By experiments made with the models, proofs have been ſhown that the new wheel has many advantages over the common wheel; and that, when it works in deep tail-water, it will carry weights in proportion of three to one, ſo that it will be particularly ſerviceable for tide-mills.

I hope on trial, before the Society, my invention will prove ſucceſsful; and am, Sir,

Your obedient ſervant,

No. 26, Brompton. J. Besant.

To the Secretary of the Society of Arts, &c.

* From the *Tranſactions of the Society for the Encouragement of Arts, &c.* vol. xix.—Ten guineas were voted to Mr. Beſant's widow for this invention.

Repeated

*** Repeated experiments of the above invention were made by the committee; from the result of which it appeared to possess some advantages over the common wheel, and to have a greater power of action.

Description of the late Mr. Besant's Water-wheel. (Plate I. fig. 2 and 3.)

A, (fig. 2.) the body of the water-wheel, which is hollow, in the form of a drum, and is so constructed as to be proof against the admission of water within it.

B, the axis on which it turns.

C, the float-boards, placed on the periphery of the wheel. Each board is obliquely fixed firm to the rim of it, and to the body of the drum.

D, the reservoir, containing the water.

E, the penstock, which regulates the quantity of water running to the wheel.

F, the current of water which has passed the wheel.

Fig. 3 is a front view of the water-wheel, showing the oblique direction in which the float-boards, C, are placed on the face of the wheel.

VI. *Experiments and Observations on certain Stony and Metalline Substances which at different Times are said to have fallen on the Earth; also on various Kinds of Native Iron.* *By* EDWARD HOWARD, *Esq. F. R. S.**

THE concordance of a variety of facts seems to render it most indisputable, that certain stony and metalline substances have, at different periods, fallen on the earth. Whence their origin, or whence they came, is yet, in my judgment, involved in complete obscurity.

The accounts of these peculiar substances, in the early annals, even of the Royal Society, have unfortunately been blended with relations which we now consider as fabulous; and the more antient histories of stones fallen from heaven, from Jupiter, or from the clouds, have evidently confounded such substances with what have been termed *ceraunia*, *bœtilia*, *ombria*, *brontia*, &c. names altogether unappropriate to substances fallen on our globe. Indeed some mislead, and others are inexpressive.

The term *ceraunia*, by a misnomer, deduced from its supposed origin, seems, as well as *bœtilia*†, to have been an-

* From the *Transactions of the Royal Society of London for* 1802.

† Mercati, Metallotheca Vaticana, p. 241.

tiently uſed to denote many ſpecies of ſtones, which were poliſhed and ſhaped into various forms, though moſtly wedge-like or triangular, ſometimes as inſtruments, ſometimes as oracles, and ſometimes as deities. The import of the names *ombria*, *brontia*, &c. ſeems ſubject to the ſame uncertainty.

In very early ages it was believed that ſtones did in reality fall, as it was ſaid, from heaven, or from the gods; theſe, either from ignorance, or perhaps from ſuperſtitious views, were confounded with other ſtones, which, by their compact aggregation, were better calculated to be ſhaped into different inſtruments, and to which it was convenient to attach a ſpecies of myſterious veneration. In modern days, becauſe exploſion and report have generally accompanied the deſcent of ſuch ſubſtances, the name of thunderbolt, or thunderſtone, has ignorantly attached itſelf to them; and becauſe a variety of ſubſtances accidentally preſent near buildings and trees ſtruck with lightning have, with the ſame ignorance, been collected as thunderbolts, the thunderbolt and the fallen metalline ſubſtance have been ranked in the ſame claſs of abſurdity. Certainly, ſince the phænomena of lightning and electricity have been ſo well identified, the idea of a thunderbolt is ridiculous. But the exiſtence of peculiar ſubſtances fallen on the earth, I cannot heſitate to aſſert; and on the concordance of remote and authenticated facts I ſhall reſt the aſſertion.

Mr. King, the learned author of "Remarks concerning Stones ſaid to have fallen from the Clouds, in theſe Days, and in antient Times," has adduced quotations of the greateſt antiquity, deſcriptive of the deſcent of fallen ſtones; and, could it be thought neceſſary to add antique teſtimonies to thoſe inſtanced by ſo profound an antiquarian, the quotations of Monſ. Falconet, in his papers upon bœtilia, inſerted in the *Hiſtoire des Inſcriptions et Belles-Lettres* *; the quotations in Zahn's *Specula Phyſico-mathematica Hiſtoriana* †; the *Fiſica Sotterranea* of Giacinto Gemma; the works of Pliny, and others, might be referred to.

Dr. Chladni, in his "Obſervations on the Maſs of Iron found in Siberia, and on other Maſſes of the like Kind," as well as in his "Obſervations on Fire-balls and hard Bodies fallen from the Atmoſphere," has collected almoſt every modern inſtance of phænomena of this nature.

Mr. Southey relates an account, juridically authenticated, of a ſtone weighing ten pounds which was heard to fall in

* Tom. vi. p. 519, et tom. xxiii. p. 228.

† Fol. 1696, vol. i. p. 385, where a long enumeration of ſtones fallen from the ſky is given.

Portugal

Portugal Feb. 19, 1796, and was taken, ſtill warm, from the ground *.

The firſt of theſe peculiar ſubſtances with which chemiſtry has interfered, was the ſtone preſented by the abbé Bachelay to the Royal French Academy. It was found on the 13th of Sept. 1768, yet hot, by perſons who ſaw it fall. It is deſcribed as follows †:

"The ſubſtance of this ſtone is of a pale aſh-gray colour; when examined with a magnifying glaſs, it is found to be interſperſed with a multitude of ſmall brilliant metallic points of a pale yellow colour; its exterior ſurface, that which, according to the abbé Bachelay, was not engaged in the earth, was covered with a ſmall and very thin ſtratum of a blackiſh matter, puffed up in ſome places, and which appeared to have been fuſed. This ſtone, when the interior of it was ſtruck with ſteel, produced no ſparks: on the other hand, when ſtruck on the thin external ſtratum, which appeared to have been attacked by fire, ſome few ſparks were elicited."

The ſpecific gravity of this ſtone was as 3535 to 1000.

The academicians analyſed the ſtone, and found it to contain

Sulphur	-	-	$8\frac{1}{2}$
Iron	-	-	36
Vitrifiable earth		-	$55\frac{1}{2}$
			100

Of their mode of analyſis, I ſhall have occaſion to ſpeak hereafter. They were induced to conclude, that the ſtone, preſented to the academy by the abbé Bachelay, did not owe its origin to thunder; that it did not fall from heaven; that it was not formed by mineral ſubſtances, fuſed by lightning; and that it was nothing but a ſpecies of pyrites, without peculiarity, except as to the hepatic ſmell diſengaged from it by marine acid. "That this ſtone, which was, perhaps, covered by a ſmall ſtratum of earth or turf, may have been ſtruck with lightning, and thus uncovered: the heat may have been ſufficiently great to fuſe the ſurface of the part ſtruck, but it may not have been long enough continued to be able to penetrate to the inſide: on this account, the ſtone has not been decompoſed. The quantity of metallic matters it contains, oppoſing leſs reſiſtance than another body to the current of the electric matter, may perhaps have contributed to determine the direction of the lightning."

The memoir is however concluded, by obſerving it to be

* Letters written during a ſhort Reſidence in Spain and Portugal, page 259.

† Here, and in the two following quotations, Mr. Howard gives the original words of the author: we have ſubſtituted faithful tranſlations.—EDIT.

ſufficiently

ſufficiently ſingular, that M. Morand le fils had preſented a fragment of a ſtone, from the environs of Coutances, alſo ſaid to have fallen from heaven, which only differed from that of the abbé Bachelay becauſe it did not exhale the hepatic ſmell with ſpirit of ſalt. Yet the academicians did not think any concluſion could be drawn from this reſemblance, unleſs that the lightning had fallen by preference on pyritical matter *.

Monſ. Barthold, profeſſeur à l'école centrale du Haut-Rhin, gave, I believe, the next, and laſt †, analytical account of what he alſo denominates *pierre de tonnerre*. He deſcribes it thus:—" The maſs of ſtone known under the name of *pierre de tonnerre d'Enſiſheim*, weighing about two quintals, has its exterior form rounded, almoſt oval, is rugged, and of a dull earthy appearance.

" The ground of the ſtone is of a blueiſh gray colour interſperſed with inſulated cryſtals of pyrites, the cryſtallization of which is confuſed, in ſome places ſcaly, accumulated, forming nodes and ſmall veins, which traverſe it in every direction: the pyrites is of a golden colour: poliſhing gives it the ſplendour of ſteel, and, when expoſed to the atmoſphere, it becomes tarniſhed and brown. One may diſtinguiſh alſo with the naked eye gray ſcaly iron ore, not ſulphureous, ſuſceptible of being attracted by the magnet, little oxidated, or approaching much to the metallic ſtate.

" The fracture is irregular, granulated, of a grain ſomewhat compact: in the inſide very ſmall fiſſures are ſeen. It does not ſtrike fire with ſteel: its texture is ſo ſoft, that it readily ſuffers itſelf to be attacked by a knife. By pounding, it is eaſily reduced to a blueiſh gray powder of an earthy odour. Sometimes there are found ſmall cryſtals of iron ore, which preſent a greater reſiſtance to the blows of the ſtamper."

The ſpecific gravity of the piece in profeſſor Barthold's poſſeſſion was 3233, diſtilled water being taken at 1000.

The analyſis of M. Barthold, of which I ſhall alſo have occaſion to ſpeak hereafter, gave in the 100,

Sulphur	- -	2
Iron	- -	20
Magneſia	- -	14
Alumina	- -	17
Lime	- -	2
Silica	- -	42
		97.

* See *Journal de Phyſique*, tom. ii. p. 251.

† A very intereſting detail of a meteor, and of ſtones fallen in July 1790 was given by profeſſeur Baudin in the *Magazin für das Neueſte aus der Phyſik*, by profeſſor Voigt.

From

From the external characters, and from his analyſis, the profeſſor conſiders the ſtone of Enſiſheim to be argillo-ferruginous; and is of opinion, that ignorance and ſuperſtition have attributed to it a miraculous exiſtence, at variance with the firſt notions of natural philoſophy *.

The account next in ſucceſſion is already printed in the Tranſactions of the Royal Society; but cannot be omitted, as it immediately relates to one of the ſubſtances I have examined. I allude to the letter received by Sir William Hamilton from the earl of Briſtol, dated from Sienna, July 12, 1794:—"In the midſt of a moſt violent thunder-ſtorm, about a dozen ſtones, of various weights and dimenſions, fell at the feet of different perſons, men, women, and children. The ſtones are of a quality not found in any part of the Sienneſe territory: they fell about eighteen hours after the enormous eruption of mount Veſuvius; which circumſtance leaves a choice of difficulties in the ſolution of this extraordinary phænomenon. Either theſe ſtones have been generated in this igneous maſs of clouds, which produced ſuch unuſual thunder; or, which is equally incredible, they were thrown from Veſuvius, at a diſtance of at leaſt 250 miles; judge then of its parabola. The philoſophers here incline to the firſt ſolution. I wiſh much, Sir, to know your ſentiments. My firſt objection was to the fact itſelf; but of this there are ſo many eye witneſſes, it ſeems impoſſible to withſtand their evidence." (Phil. Tranſ. for 1795, p. 103.) Sir William Hamilton, it ſeems, alſo received a piece of one of the largeſt ſtones, which weighed upwards of five pounds; and had ſeen another which weighed about one. He likewiſe obſerved, that the outſide of every ſtone which had been found, and had been aſcertained to have fallen from the clouds near Sienna, was evidently freſhly vitrified, and was black, having every ſign of having paſſed through an extreme heat; the inſide was of a light gray colour, mixed with black ſpots and ſome ſhining particles, which the learned there had decided to be pyrites.

In 1796 a ſtone weighing 56 pounds was exhibited in London, with ſeveral atteſtations of perſons who, on the 13th of December 1795, ſaw it fall, near Wold Cottage, in Yorkſhire, at about three o'clock in the afternoon. It had penetrated through twelve inches of ſoil and ſix inches of ſolid chalk rock; and, in burying itſelf, had thrown up an immenſe quantity of earth to a great diſtance: as it fell, a number of exploſions were heard, about as loud as piſtols.

* See *Journal de Phyſique*, Ventoſe, an. 8, p. 169.

In

In the adjacent villages, the ſounds heard were taken for guns at ſea; but, at two adjoining villages, were ſo diſtinct of ſomething ſingular paſſing through the air, towards the habitation of Mr. Topham, that five or ſix people came up to ſee if any thing extraordinary had happened to his houſe or grounds. When the ſtone was extracted, it was warm, ſmoked, and ſmelt very ſtrong of ſulphur. Its courſe, as far as could be collected from different accounts, was from the ſouth-weſt. The day was mild and hazy, a ſort of weather very frequent in the Wold hills, when there are no winds or ſtorms; but there was not any thunder or lightning the whole day. No ſuch ſtone is known in the country. There was no eruption in the earth; and, from its form, it could not come from any building; and, as the day was not tempeſtuous, it did not ſeem probable that it could have been forced from any rocks, the neareſt of which are thoſe of Flamborough Head, at a diſtance of twelve miles*. The neareſt volcano I believe to be Hecla in Iceland.

The exhibition of this ſtone as a ſort of ſhow, did not tend to accredit the account of its deſcent, delivered in a hand-bill at the place of exhibition; much leſs could it contribute to remove the objections made to the fall of the ſtones preſented to the Royal French Academy. But the right hon. Preſident of the Royal Society, ever alive to the intereſt and promotion of ſcience, obſerving the ſtone ſo exhibited to reſemble a ſtone ſent to him as one of thoſe fallen at Sienna, could not be miſled by prejudice: he obtained a piece of this extraordinary maſs, and collected many references to deſcriptions of ſimilar phænomena. At length, in 1799, an account of ſtones fallen in the Eaſt Indies was ſent to the preſident by John Lloyd Williams, eſq. which, by its unqueſtionable authenticity, and by the ſtriking reſemblance it bears to other accounts of fallen ſtones, muſt remove all prejudice. Mr. Williams has ſince drawn up the following more detailed narrative of facts.

Account of the Exploſion of a Meteor near Benares, in the Eaſt Indies; and of the Falling of ſome Stones at the ſame Time, about 14 *Miles from that City. By* John Lloyd Williams, *Eſq. F. R. S.*

A circumſtance of ſo extraordinary a nature as the fall of ſtones from the heavens could not fail to excite the wonder and attract the attention of every inquiſitive mind.

Among a ſuperſtitious people, any preternatural appearance is viewed with ſilent awe and reverence: attributing the

* Extracted from the printed paper delivered at the place of exhibition.

cauſes

cauſes to the will of the Supreme Being, they do not preſume to judge the means by which they were produced, nor the purpoſes for which they were ordered; and we are naturally led to ſuſpect the influence of prejudice and ſuperſtition in their deſcriptions of ſuch phænomena: my inquiries were therefore chiefly directed to the Europeans, who were but thinly diſperſed about that part of the country.

The information I obtained was, that on the 19th of December 1798, about eight o'clock in the evening, a very luminous meteor was obſerved in the heavens, by the inhabitants of Benares and the parts adjacent, in the form of a large ball of fire; that it was accompanied by a loud noiſe reſembling thunder; and that a number of ſtones were ſaid to have fallen from it near Krakhut, a village on the north ſide of the river Goomty, about 14 miles from the city of Benares.

The meteor appeared in the weſtern part of the hemiſphere, and was but a ſhort time viſible: it was obſerved by ſeveral Europeans, as well as natives, in different parts of the country.

In the neighbourhood of Juanpoor, about twelve miles from the ſpot where the ſtones are ſaid to have fallen, it was very diſtinctly obſerved by ſeveral European gentlemen and ladies; who deſcribed it as a large ball of fire, accompanied with a loud rumbling noiſe, not unlike an ill-diſcharged platoon of muſketry. It was alſo ſeen, and the noiſe heard, by various perſons at Benares. Mr. Davis obſerved the light come into the room where he was, through a glaſs window, ſo ſtrongly as to project ſhadows from the bars between the panes, on a dark coloured carpet, very diſtinctly; and it appeared to him as luminous as the brighteſt moonlight.

When an account of the fall of the ſtones reached Benares, Mr. Davis, the judge and magiſtrate of the diſtrict, ſent an intelligent perſon to make inquiry on the ſpot. When the perſon arrived at the village near which the ſtones were ſaid to have fallen, the natives, in anſwer to his inquiries, told him, that they had either broken to pieces, or given away to the *teſſildar* (native collector) and others, all that they had picked up; but that he might eaſily find ſome in the adjacent fields, where they would be readily diſcovered (the crops being then not above two or three inches above the ground) by obſerving where the earth appeared recently turned up. Following theſe directions, he found four, which he brought to Mr. Davis: moſt of theſe the force of the fall had buried, according to a meaſure he produced, about ſix inches deep, in fields which ſeemed to have been recently watered; and

it

it appeared, from the man's deſcription, that they muſt have lain at the diſtance of about a hundred yards from each other.

What he further learnt from the inhabitants of the village concerning the phænomenon was, that about eight o'clock in the evening, when retired to their habitations, they obſerved a very bright light, proceeding as from the ſky, accompanied with a loud clap of thunder, which was immediately followed by the noiſe of heavy bodies falling in the vicinity. Uncertain whether ſome of their deities might not have been concerned in this occurrence, they did not venture out to inquire into it until the next morning; when the firſt circumſtance which attracted their attention was the appearance of the earth being turned up in different parts of their fields as before mentioned, where, on examining, they found the ſtones.

The aſſiſtant to the collector of the diſtrict, Mr. Erſkine, a very intelligent young gentleman, on ſeeing one of the ſtones, brought to him by the native ſuperintendant of the collections, was alſo induced to ſend a perſon to that part of the country to make inquiry; who returned with ſeveral of the ſtones, and brought an account ſimilar to that given by the perſon ſent by Mr. Davis, together with a confirmation of it from the cauzy, (who had been directed to make the inquiry,) under his hand and ſeal.

Mr. Maclane, a gentleman who reſided very near the village of Krakhut, gave me part of a ſtone that had been brought to him the morning after the appearance of the phænomenon, by the watchman who was on duty at his houſe; this, he ſaid, had fallen through the top of his hut, which was cloſe by, and buried itſelf ſeveral inches in the floor, which was of conſolidated earth. The ſtone muſt, by his account, previous to its having been broken, have weighed upwards of two pounds.

At the time the meteor appeared, the ſky was perfectly ſerene; not the ſmalleſt veſtige of a cloud had been ſeen ſince the 11th of the month, nor were any obſerved for many days after.

Of theſe ſtones, I have ſeen eight, nearly perfect, beſides parts of ſeveral others, which had been broken by the poſſeſſors to diſtribute among their friends. The form of the more perfect ones appeared to be that of an irregular cube, rounded off at the edges; but the angles were to be obſerved on moſt of them. They were of various ſizes, from about three to upwards of four inches in their largeſt diameter; one of them, meaſuring four inches and a quarter, weighed two pounds twelve ounces. In appearance, they were exactly

actly ſimilar: externally they were covered with a hard black coat or incruſtation, which in ſome parts had the appearance of varniſh, or bitumen; and on moſt of them were fractures, which, from their being covered with a matter ſimilar to that of the coat, ſeemed to have been made in the fall, by the ſtones ſtriking againſt each other, and to have paſſed through ſome medium, probably an intenſe heat, previous to their reaching the earth. Internally, they conſiſted of a number of ſmall ſpherical bodies, of a ſlate colour, embedded in a whitiſh gritty ſubſtance, interſperſed with bright ſhining ſpiculæ, of a metallic or pyritical nature. The ſpherical bodies were much harder than the reſt of the ſtone: the white gritty part readily crumbled, on being rubbed with a hard body; and, on being broken, a quantity of it attached itſelf to the magnet, but more particularly the outſide coat or cruſt, which appeared almoſt wholly attractable by it.

As two of the more perfect ſtones which I had obtained, as well as parts of ſome others, have been examined by ſeveral gentlemen well verſed in mineralogy and chemiſtry, I ſhall not attempt any further deſcription of their conſtituent parts; nor ſhall I offer any conjecture reſpecting the formation of ſuch ſingular productions, or even record thoſe which I have heard of others, but leave the world to draw their own inferences from the facts above related. I ſhall only obſerve, that it is well known there are no volcanos on the continent of India; and, as far as I can learn, no ſtones have been met with in the earth, in that part of the world, which bear the ſmalleſt reſemblance to thoſe above deſcribed.

[To be continued.]

VII. *Mineralogical Notice reſpecting two great Peculiarities lately found in Iron-ſtone from Hachenburg and Iſchenburg. By Mr.* CRAMER, *Counſellor of Mines at Altenkirchen* *.

THE firſt mineral I ſhall here mention is native iron. It is well known that a diſpute has long exiſted among mineralogiſts reſpecting the actual exiſtence of this ſubſtance; that by ſome it has always been doubted; and that, beſides the monſtrous maſs of which profeſſor Pallas has given a circumſtantial deſcription, few ſpecimens have ever been produced to give ſupport to the aſſertion, that this mineral is found in a natural ſtate. The certainty of its exiſtence has

* From *Der Geſellſchaft Naturforſchender Freunde zu Berlin Neue Schriften*, vol. ii.

reſted hitherto on very ſlight foundations; and, as moſt of our mineralogiſts have always ſpoken merely of probability, they have ſuffered the doubt to remain, whether the maſſes of iron which have been found were not artificial productions, or the effect of ſubterranean fire, &c. I muſt confeſs that I have myſelf doubted, on good grounds, of the reality of thoſe ſpecimens of ſuppoſed native iron which I have ſeen in different collections of Germany.

If ſuch difficulty of belief is excuſable in a ſcience where every thing ought to be determined by obſervation and experience; a mineralogiſt, however, ought not to perſiſt in a previouſly adopted opinion, when he has been convinced of the contrary by his own eyes. A conviction of this kind occurred to myſelf the preſent year, and by a ſingular accident. A company, who are proprietors of two iron-works in this county, being in want of good iron-ſtone, and on that account prevented from manufacturing the iron of the beſt quality, received a letter from the neighbouring county of Hachenburg containing an offer of a thouſand waggon loads of iron-ſtone for five years, from a quarry of iron-ſtone which had been lately diſcovered at a ſmall diſtance from the borders of this county. The offer was accepted, and the iron-ſtone was delivered at the two works in pretty large maſſes, which were afterwards broken, according to the cuſtom uſual in this part of the country, with ſmall hammers. After its arrival, one of the workmen put a piece under the hammer; but, as it reſiſted every effort made to break it, he was naturally induced to examine it more narrowly. He immediately carried it to a forge in the neighbourhood; and the ſmith, having put it into the fire, forged from it, in a few minutes, ſome excellent horſe-ſhoe nails. It is, however, much to be regretted, that, through the ignorance and careleſſneſs of the workman, this remarkable production of nature was, in a great meaſure, deſtroyed. It weighed altogether four pounds; and only a few fragments, which had almoſt all been in the fire, and which exhibit on the one ſide the native iron, and on the other the forged nails, were ſaved: but theſe fragments are preſerved by the poſſeſſors with as much care as if they were ſacred relics. One piece, which came into my poſſeſſion, ſeems to have been very little in the fire: it weighs nearly half a pound, has a ſhining fracture of a ſteel gray colour, is of a browniſh colour on the outſide running into black, and perfectly malleable.

Being induced by this ſingular phænomenon to make ſome reſearches in the place where it occurred, I repaired thither,

thither, and found a pit newly opened which had a greater reſemblance to a quarry than an iron-mine. Some old pits, of no great extent, one of which forms at preſent a ſmall bog, ſeemed to indicate that a mine had been here worked formerly; but never to any great extent, becauſe the ſtrata of iron-ſtone, very compact, half a fathom in thickneſs, were found at the depth of only half a fathom below the ſurface of the earth.

The whole ſurface of the ſurrounding diſtrict is covered with huge irregular maſſes of baſaltes, a prodigious quantity of which forms in the neighbouring foreſt a group of rocks known under the name of *Wolfſtein*, where large pieces of baſaltes are heaped upon each other, as if by art, to the height of nearly ten fathoms; and, as this accumulation occupies a circumference of ſome hundred fathoms, this maſs, in conſequence of its gravity, and the preſſure thence ariſing, may have deviated from its perpendicular direction, and produced thoſe numerous apertures and fiſſures in the neighbourhood. It forms a very awful appearance in the dark foreſt; which, however, is pretty much on a level, and excites a well-grounded fear, that, in the courſe of time, conſiderable fragments of it may tumble down and cruſh ſome of the inhabitants who ſtray about in the neighbourhood, and who often viſit this Wolfſtein, which they conſider as the ruins of an antient caſtle.

About 200 fathoms to the eaſt of the above iron-ſtone quarry lie the boundaries of the territory of Orange-Naſſau; where the mountains evidently conſiſt of ſtrata, and where bituminous wood may be found almoſt every where at a certain depth. I ſhall abſtain from all further deſcription, as a full account of this diſtrict may be ſeen in a ſmall work on this ſubject, written a few years ago by Mr. Becher, counſellor of mines at Dillenburg, and alſo in the third part of the Mineralogical Deſcription of the Country of Naſſau-Orange. I muſt however obſerve, that near the boundaries of Naſſau and Hachenburg the mountain changes, and the argillaceous ſlate-mountains begin. The diſtrict around the iron-ſtone pits of Hachenburg conſiſts of argillaceous ſlate. The ſtratum itſelf is compoſed chiefly of brown hematite almoſt without variation, in which particles of red iron ochre, lithomarga, and argil, occur. The hematite is pretty fuſible, and abundant in metal, and produces good malleable iron. According to the account of the director of the works, who was examined on the ſubject, the above piece of native iron was imbedded in a round cruſt of ſuch hematite: it was ſomewhat grown on the one ſide, and the iron-ſtone on it was

very hard and compact. He thinks he knows the place where it was broken off, and that more of the ſame kind will hereafter be found: but this, notwithſtanding the ſtricteſt ſearch, has not yet been the caſe.

I am happy therefore that I have been able to give this occaſional notice of a phænomenon ſo remarkable in the mineral kingdom: if I receive any further information on the ſubject, I ſhall not fail to communicate it.

The ſecond remarkable phænomenon in the mineral kingdom occurred to me in the county of Wachterſbach, on the river Kinzig, not far from the town of Gelnhauſen, where I reſided ſome time laſt ſummer, for the benefit of my health, with the reigning count. An iron-work, ſituated at the diſtance of two miles from the count's palace, belongs to Mr. von Lilienſtern, of Franckfort, and is one of the completeſt and moſt beautiful I have ſeen. It conſiſts of an elegant manſion and tavern, a large edifice for the ſubalterns, a caſting-houſe, a forge, and various large and ſmall hammers, which are ſituated ſo advantageouſly under each other that they can all be driven together by the ſame water. The whole forms a ſmall colony, and exhibits to the amateurs of ſuch eſtabliſhments a moſt agreeable proſpect, eſpecially as it is variegated by romantic walks, and agreeable fruit- and kitchen-gardens. The ſmelting of the iron-ſtone is performed in a common high furnace. The product, according to the account of the founder, may be about 24,000 pounds per week, which amounts to nearly 3500 pounds in 24 hours. The iron obtained, as far as I can judge, is malleable, and of a good quality; but, in particular, very proper for caſt work, on which alone the workmen were employed during two viſits which I paid to the eſtabliſhment. They have a very able director, and caſt not only the moſt beautiful round fire-ſtoves, according to the antique mode, with many appropriate ornaments, but alſo pots and other veſſels, according to the demand and other circumſtances. They are employed in making ſuch articles, and caſting the raw iron into the uſual priſmatic pigs, which is afterwards ſubjected to the operation of the different hammers.

Notwithſtanding the great extent of the Budinger foreſt, and the private woods belonging to the count in the neighbourhood, the proprietors of this iron-work have been obliged to purchaſe the neceſſary charcoal at a very dear rate, and to bring ſome of it from a great diſtance, becauſe the numerous ſalt-works, glaſs-houſes, and other ſmaller manufactories in the neighbourhood, naturally increaſe the conſumption; and the many rights of commonage in the Budinger foreſt belonging to

to the adjacent country, and the neighbouring towns and villages, who employ their privileges to the fulleſt extent, are a great impediment to the cultivation of timber.

The iron-ſtone for this work is procured chiefly from the neighbouring principality of Iſenberg-Birſtein, and in particular from the diſtrict of Wenings, near which there have long been a great many large iron-ſtone works. In all theſe the iron-ſtone is found in ſtrata; and the ſtrata in general are only from four or five inches to one foot in breadth; but in the above-mentioned principal work they are ſometimes from one to two fathoms in breadth, but at preſent they have decreaſed to two or three feet. The iron-ſtone dug up from the different pits, and employed at the Lilienſtern work, is in part compact brown iron-ſtone, and partly brown hematite, which is found for the moſt part in pretty round hard pieces without much variation. It is exceedingly argillaceous, and ſo difficult to be fuſed, that it requires a conſiderable addition of calcareous ſtone, a large quantity of which is found in the county of Wachterſbach. In this diſtrict, at preſent, the work has only a few iron-ſtone pits, none of which are of much importance: one of them, however, on account of the ſingular metallurgic property of the iron-ſtone it produces, deſerves the attention of mineralogiſts.

Under the exterior cruſt there firſt occurs a ſtrong ſtratum of white and red ſandſtone in alternate order, which extends to the diſtance of ſeveral miles in the neighbourhood. Under this lies a gray argillaceous ſtone, which feels ſomewhat greaſy, ſoft, and friable, and is ſcarcely three inches in thickneſs: below this there is a ſtratum of excellent iron-ſtone of equal thickneſs, the bottom of which conſiſts of ſolid ſandſtone, of a kind of millſtone which frequently occurs in theſe diſtricts. This iron-ſtone is different from every other kind in the neighbourhood: it is a compact argillaceous iron-ſtone of a reddiſh brown colour and of a rough fracture, ſometimes mixed with ſhells, among which there is found, though very ſeldom, a variety which has a fibrous fracture, with an almoſt metallic ſplendour, and ſeems worthy of further examination.

When I viſited this work, ſome maſſes of this compact iron-ſtone were dug up which contained charcoal. This charcoal was found looſe in the iron-ſtone, and partly grown into its ſubſtance and adhering to it. By what natural or artificial fire this charcoal was burnt, and by what ſingular revolution it was carried to the depth of from three to four fathoms, and there ſo intimately combined with the iron-

ſtone that it ſeems to form one body with it, no mineralogiſt can with certainty explain.

The hypotheſis which I have ventured to form of this ſingular and certainly uncommon ſubterranean mixture is, that the charcoal was burnt in the neighbourhood either in the uſual manner or by natural fire, and that ſome fragments of it, by ſome convulſion of nature, were thrown to the above depth, where they united with the ferruginous matter, and by theſe means produced the above remarkable phænomenon. On many fragments one can obſerve the tranſition of the not completely burnt wood into iron-ſtone; even the bark of the wood, actually converted into iron-ſtone, may be clearly diſtinguiſhed; and the perfectly black natural or artificial charcoal, poſſeſſing all the properties of the charcoal of burnt wood, lies undecompoſed in it: but it would be worth while to ſubject it to a more accurate chemical reſearch, in order to examine its component parts. I hope to obtain, by one of my friends, a more detailed account of this ſubterranean phænomenon; and therefore I ſhall only add at preſent, that this iron-ſtone is exceedingly eaſy of fuſion, and ſo much ſo, that it is uſed as a flux for other kinds, and, in ſome meaſure, indiſpenſably neceſſary at the forges, eſpecially when caſt articles are to be manufactured with advantage.

VIII. *Memoir on the Anatomy of Vegetables. Read before the Phyſical Claſs of the Inſtitute by* C. Mirbel *.

Of the Elementary Organs.

AFTER ſtudying the works of Duhamel, Senebier, De Sauſſure, and ſeveral other philoſophers, without being able to form any fixed opinion of the internal anatomy of vegetables, it appeared to me that it would be more advantageous to ſtudy nature in her own works. I endeavoured to baniſh from my mind every thing ſyſtematic, in order that my obſervations might be free from every kind of bias. All vegetables have too much relation in the mode of the development of their organization not to exhibit great ſimilitude. This reflection, which naturally preſents itſelf to the mind, induced me to direct my firſt obſervations to one ſpecies. I made choice of the elder, as having a looſer texture, and eaſier to be obſerved, than that of many other vegetables. During ſix months, I employed all the known proceſſes for

* From the *Journal de Phyſique*, Germinal, an. 10.

acquiring

acquiring a knowledge of the organs of that plant. I uſed comparatively four or five different microſcopes; and, when I ſuppoſed that I had got the whole ſeries of facts, I tried the ſame obſervations on a great number of other vegetables. The compariſons I then made greatly contributed to give me information reſpecting the nature and form of the organs; and to obviate, by every mean poſſible, the illuſions which might lead me into a falſe path, I begged C. Maſſey, my friend and fellow-labourer, to reviſe my obſervations, and to examine them with the ſevereſt criticiſm. His obſervations compared with mine have either confirmed or rectified them.

I ſhall now give a deſcription of the parts which I call elementary organs, becauſe all the other organs are compoſed of them.

Chap. I.

Of thoſe Parts which are diſtinguiſhed by the naked Eye.

Vegetables in general are compoſed, as every body may have obſerved, of ſoft and hard parts. Some, indeed, ſuch as muſhrooms and fuci, ſeem to be formed entirely of a homogeneous ſubſtance, pretty ſoft; but this claſs is not very numerous.

The ſtem of the moſt perfect plants preſents at its ſurface a coloured ſubſtance of greater or leſs thickneſs, which is the bark. It adheres ſtrongly to the interior parts in a great many of the monocotyledons, and ſometimes even is confounded and connected with them in ſuch a manner that it is impoſſible to diſtinguiſh them. It may in this caſe be ſaid that no bark exiſts. This phænomenon is obſerved in the palms, gramineous plants, &c. But in the dicotyledons and ſome monocotyledons the bark, very diſtinct from the reſt of the tiſſue, forms an exterior ſtratum, which may be eaſily detached.

Below the bark is found the wood more compact, harder, and more connected in all its parts, and which ſeems to be formed of longitudinal fibres ſtrongly cemented to each other. In the monocotyledons without bark there is found, immediately below the epidermis, a fine tranſparent membrane, which is the exterior part of the vegetable.

The wood, as the learned Desfontaines has ſaid in his excellent memoir on the Comparative Anatomy of Vegetables, is diſtributed lengthwiſe in the ſtem and branches of the monocotyledons in delicate threads: theſe threads are often parallel, and ſometimes convergent one towards the other; they unite one and one, two and two, or divide themſelves, and become ramified in threads of ſtill greater fineneſs. All

theſe threads are ſurrounded with a ſoft, elaſtic, ſpongy ſubſtance, eaſily torn, and generally whitiſh, which is called the pith, and to which I ſhall give the name of *parenchyme*, that it may not be confounded with the pith of the dicotyledon plants. The wood of the latter, lying always under the bark, is not divided into diſtinct threads; it generally forms a cylinder, in the centre of which is placed the pith, as in a caſe. Some plants, however, evidently furniſhed with two cotyledons, exhibit ligneous filaments ſimilar to thoſe of the monocotyledons, running along the whole length of the medullary canal: but theſe are exceptions which do not deſtroy the general rule.

In trees or ſhrubs with two cotyledons there are almoſt always obſerved diſtinct lines of the wood, which proceed from the pith, traverſe the ligneous cylinder, and end at the bark. They appear on the tranſverſal ſection of the trunk, ſtem, branches, and twigs, like the hour-lines of a dial. They are called the medullary radii. They ſeldom ſhow themſelves in the ſtems of the dicotyledon herbs, and do not exiſt in the monocotyledons either herbaceous or ligneous.

In the leaves, flowers, pericarpia, &c. there are found alſo parts of greater or leſs ſoftneſs, and greater or leſs hardneſs, the ſubſtance of which appears to be ſimilar to the bark, pith, or wood.

Such are the different parts which vegetables exhibit to the naked eye. We muſt now examine the elementary organs which enter into their compoſition.

Chap. II.

Of the Membranous Tiſſue.

Vegetables are compoſed of a membranous tiſſue, which varies in its form and conſiſtence, not only in the different ſpecies, but even in the ſame individual. I ſhall not here examine whether the membranes are compoſed of organic fibres, ranged cloſe to each other and united by a gluten, as ſome authors aſſert. This ſuppoſition is ſuſceptible neither of ſtrict demonſtration, nor a formal refutation; it is one of thoſe ſyſtems which amuſe the mind when reſearch becomes fruitleſs. I ſhall content myſelf with ſtating, that, whatever may have been the perſeverance of my obſervations, I never obſerved real fibres in vegetables; the filaments to which that name has been given are only membranes, which tear into longitudinal ſtripes: ſuch were the delicate filaments which Duhamel ſeparated from a bit of wood which he obſerved through the microſcope.

The membranous tiſſue, though continued in all its parts,

forms two kinds of different organs; the cellular tiſſue, and the tubular tiſſue.

Chap. III.

Of the Cellular Tiſſue.

This tiſſue preſents to the obſerver a ſeries of membranous bags, which on the firſt view ſeem to have no communication with each other. They are not ſmall bladders or utriculi, as moſt authors aſſert; they are a membrane, which bends itſelf, in ſome meaſure, to form vacuities contiguous to each other. In the parts where theſe cells experience no foreign preſſure, they are all equally dilated, their tranſverſal and vertical ſections preſent hexagons ſimilar to the alveolæ of bee-hives; each ſide of theſe geometrical figures is common to two cells, and the whole tiſſue is wonderfully regular: but, when the tiſſue is compreſſed, the hexagons loſe their ſhape, and are converted ſometimes into parallelograms more or leſs elongated. The membranous ſides of the cells are exceedingly thin and colourleſs: they are tranſparent like glaſs, and their organization is ſo delicate, that it cannot be perceived even with the help of the moſt powerful microſcopes. They are generally filled with pores, the apertures of which do not certainly exceed the 300th part of a line; theſe pores are bordered with ſmall unequal and glandulous rolls, which intercept the light, and refract it with force when they receive its rays. The cellular tiſſue is ſpongy, elaſtic, and without conſiſtence; when immerſed in water it becomes altered, and, in a little time, is even deſtroyed: it is then reduced to a kind of mucilage. Theſe pores eſtabliſh a communication between one cell and another, and ſerve for the transfuſion of the juices in that tiſſue, which is exceedingly ſlow. I muſt alſo obſerve, that it is not a *conductor* of the fluids diffuſed throughout the vegetable, and that it produces nothing of itſelf.

I have ſaid that the membranes are tranſparent and colourleſs: when the tiſſue is diſengaged from every foreign body, this is true; but it is often marked by colouring ſubſtances, which tarniſh its tranſparency. This tiſſue exiſts in all vegetables, but not in the ſame proportion. Muſhrooms and fuci appeared to me to be compoſed only of cellular tiſſue. The bark of monocotyledons and dicotyledons is almoſt entirely formed of it: in theſe, it is generally ſomewhat compreſſed between the epidermis and the wood; it is filled with reſinous juices, commonly coloured green, but ſometimes red or yellow, according to the nature of the vegetable. This gives different tints to the epidermis, which is nothing

elſe than the exterior ſide of the firſt row of cells, as the illuſtrious Malphigi ſuppoſed. The pith in all plants is compoſed of hexagonal cells. In herbaceous plants, and particularly thoſe which are highly ſucculent, theſe cells are often filled with juices more or leſs thick or coloured. In ligneous plants, naturally drier, they are, on the other hand, almoſt entirely empty, and tranſparent. The cellular tiſſue in bulbous roots is pulpy and ſucculent; in the cotyledons it is hard and brittle; and in the albumen and ſeeds it is dry and arid. The parenchyme of the leaves, of the bracteæ, ſtipulæ, and calyces, is formed by cells filled with a juice almoſt always coloured, and green. The rich corollæ, which diſplay to the light the elegance of their forms and the ſplendour of their colours, but of which the beauty and freſhneſs vaniſh in a moment, are not ſo thin as the delicate membranes of the cellular tiſſue: the juices which ſwell the tranſparent utriculi of which they are formed give them theſe colours; the one ſometimes diffuſed into the other by imperceptible tints, ſometimes abruptly oppoſed, and heightening their ſplendour by the contraſt. Here the cellular tiſſue is ſo delicate, that the ſlighteſt touch is ſufficient to alter and tarniſh it: the leaſt preſſure reduces it to mucilage, and it appears to be the momentaneous product of the air and water. This tiſſue is obſerved alſo in the ſtamina and the piſtils. The pollen, that fine duſt which contains the ſubtile fluid neceſſary for fecundation, appears to be only an accumulation of ſmall bags formed of the cellular tiſſue: in a word, it is this tiſſue which, by dilating itſelf, produces ſucculent fruits.

The cells are proportionally more abundant in herbs than in trees, and in young ſhoots than in old timber. The embryo is compoſed almoſt entirely of cellular tiſſue. The medullary radii, which extend from the centre to the circumference in the trunks and branches of trees with two cotyledons, are ſometimes alſo nothing but a thin membrane of cells.

[To be continued.]

IX. *Method of whitening the Gray Marine Salt to fit it for domeſtic Purpoſes inſtantaneouſly, and without the Aid of Heat. By* Pajot Descharmes*.

GRAY or unrefined marine ſalt, as every body knows, is covered with a thin earthy cruſt which alters more or leſs its whiteneſs; and it is a matter of ſome conſequence, both in

* From the ſame.

regard

regard to cleanlineſs and health, to purify it from this heterogeneous ſubſtance which covers all the faces of its cryſtals.

Hitherto this ſalt has been purified or refined only by ſolution, filtration, or precipitation, according as the operation is performed on a large or a ſmall ſcale, and then by evaporation. This method requires time, wood or charcoal, and proper veſſels. Many perſons, however, are unacquainted with this proceſs; ſometimes they have not leiſure to employ it; and ſometimes they have neither the neceſſary veſſels nor fuel.

I have thought, therefore, that a proceſs which requires neither fire nor particular veſſels, is attended with no expenſe, may be practiſed at all times, and is within the reach of every one, might be of general utility. This method is as follows:

Take four ounces of gray ſalt, and, if dry, beſprinkle it gently with water till it be only what is called moiſt; but it will be very ſeldom neceſſary to have recourſe to this operation. Put the ſalt into the corner of a table napkin or piece of linen cloth, and form the cloth into a kind of knot or bag, which you muſt hold in one hand, while with the other you rub and ſhake the ſalt againſt the inſide of the cloth for the ſpace of half an hour. Then ſhift the ſalt to another place of the cloth, ſucceſſively repeating the ſame manœuvre ſix, ſeven, or eight times, according as the ſalt is more or leſs gray. After the ſalt has been rolled for the firſt time, the cloth begins to exhibit ſpots occaſioned by the earth which the ſalt depoſits, and of which the intenſity ſenſibly decreaſes at each change of place till they entirely diſappear. In general, the ſalt muſt be beſprinkled every two or three times that its place is changed. The bleaching will be accelerated by pounding the ſalt ſlightly before it is beſprinkled.

After two or three aſperſions and rubbings, the ſalt is, in general, as pure and white as that refined, according to the uſual method, by ſolution and evaporation. The loſs in both caſes is nearly the ſame; that is to ſay, about an eighth, when the ſalt is dry, and when care has been taken at each change of place to ſhake off the grains which adhere to the cloth. It is, for the moſt part, the whiteſt ſalt that adheres in this manner; and it may be ſhaken off without fear, as the earth depoſited on the cloth cannot detach itſelf till the cloth is dry. The gray ſalt of commerce contains in general 12½ per cent. of foreign matters, nearly one-half of which is water, and about as much earth.

This proceſs, which on account of its ſimplicity I conſider as likely to become uſeful for domeſtic purpoſes, might perhaps be applicable to ſalt manufactories and ſalt refineries.

X. *On the Alteration which Light produces on Red ſulphurated Arſenic, known under the Name of Realgar. Read in the French Inſtitute by* B. G. SAGE, *Director of the Firſt School of Mines* *.

LIGHT alters the red colours of oxides or metallic calces. Minium as well as red oxide of mercury, when expoſed to the light, becomes black, though in cloſe glaſs jars.

One of the moſt celebrated chemiſts, Scheele, made known that muriate of ſilver loſt its white colour by light even when under water. The ſame philoſopher, having decompoſed the light by means of a priſm, found that muriate of ſilver, heretofore known under the name of *luna cornea*, was coloured

In 4 ſeconds, by - the violet ray;
In 25 ſeconds, by - the purple ray;
In 29 ſeconds, by - the blue ray;
In 37 ſeconds, by - the green ray;
In 5 minutes, by - the yellow ray;
In 12 minutes, by - the orange ray;
In 20 minutes, by - the red ray.

Native realgar, which is found in conſiderable maſſes among the volcanic productions of Japan, is of a brilliant purple red when it has been poliſhed. Large maſſes of it are found alſo in the tin mines in the province of Kianfu, five days journey from Nankin. Le Camus had a piece of it which weighed twenty-eight pounds. The ſame naturaliſt has ſome worked realgar, in the centre of which there is a vein of calcareous ſpar. The Chineſe and Indians employ it for making pagodas and vaſes. Having put one of theſe pagodas into a glaſs caſe, to which neither the ſun nor external air had any acceſs, I found, ſome months after, that the pagoda had loſt its brilliancy and its red colour, and was covered with an efflorescence of an orange-yellow colour, which readily detached itſelf and fell on the ſtand: having collected this efflorescence, and fuſed it in a crucible, it preſented realgar.

I have made known that orpiment, or yellow ore of arſenic, the flakes of which are of a brilliant golden-yellow colour, and ſemi-tranſparent, paſſes to the ſtate of realgar, or ſulphurated red ore of arſenic, when fuſed or ſublimated. I have preſented to the Inſtitute a piece of orpiment, a part of which I have made to paſs to the ſtate of realgar by applying beneath it the flame of a taper by means of a blowpipe: for this purpoſe, the flame muſt not be too ſtrong.

* From the ſame.

Pott

Pott has made known that orpiment contains only a tenth of ſulphur. As this ſubſtance paſſes to the ſtate of realgar merely by the action of heat, and afterwards repaſſes to the ſtate of orpiment by the contact of light, it is evident that theſe two ſubſtances, ſo different in colour, are compoſed of the ſame elements. Having taken the realgar pagoda from the glaſs caſe, I ſaw that a part of it, which had not been expoſed to the immediate contact of the light, had retained its colour and brilliancy.

The realgar which is ſublimated at the Solfaterra under the form of octaedral cryſtals, known under the name of *ruby of arſenic*, efflores̈ces alſo by the light.

XI. *The Marquis of Worceſter's Scantlings of Inventions.*

[This little tract, firſt publiſhed in 1655. being not eaſy to be met with, we inſert a copy of it at the requeſt of a number of our readers, and we flatter ourſelves it will be acceptable to all of them.]

A Century of the Names and Scantlings of Inventions by me already practiſed.

I. *Seals abundantly ſignificant.*

SEVERAL ſorts of ſeals, ſome ſhowing by ſcrews, others by gages faſtening or unfaſtening all the marks at once; others by additional points and imaginary places, proportionable to ordinary eſcocheons and ſeals at arms, each way palpably and punctually ſetting down (yet private from all others but the owner, and by his aſſent) the day of the month, the day of the week, the month of the year, the year of our Lord, the names of the witneſſes, and the individual place where any thing was ſealed, though in ten thouſand ſeveral places, together with the very number of lines contained in a contract, whereby falſification may be diſcovered, and manifeſtly proved, being upon good grounds ſuſpected.

Upon any of theſe ſeals a man may keep accounts of receipts and diſburſements from one farthing to an hundred millions, punctually ſhowing each pound, ſhilling, penny, or farthing.

By theſe ſeals likewiſe any letter, through written but in Engliſh, may be read and underſtood in eight ſeveral languages, and in Engliſh itſelf to clean contrary and different ſenſe, unknown to any but the correſpondent, and not to be read or underſtood by him neither, if opened before it arrive unto him; ſo that neither threats, nor hopes of reward, can make

make him reveal the ſecret, the letter having been intercepted, and firſt opened by the enemy.

II. *Seals private and particular to each Owner.*

How ten thouſand perſons may uſe theſe ſeals to all and every of the purpoſes aforeſaid, and yet keep their ſecrets from any but whom they pleaſe.

III. *A One-line Cypher.*

A cypher and character ſo contrived, that one line, without returns and circumflexes, ſtands for each and every of the twenty-four letters; and as ready to be made for the one letter as the other.

IV. *Reduced to a Point.*

This invention, refined and ſo abbreviated, that a point only ſhoweth diſtinctly and ſignificantly any of the twenty-four letters; and theſe very points to be made with two pens, ſo that no time will be loſt, but as one finger riſeth the other may make the following letter, never clogging the memory with ſeveral figures for words and combination of letters; which with eaſe, and void of confuſion, are thus ſpeedily and punctually, letter for letter, ſet down by naked and not multiplied points. And nothing can be leſs than a point, the mathematical definition of being *cujus pars nulla*. And of a motion no ſwifter imaginable than ſemiquavers or releſhes, yet applicable to this manner of writing.

V. *Varied ſignificantly to all the Twenty-four Letters.*

A way by circular motion, either along a rule or ringwiſe, to vary any alphabet, even this of points, ſo that the ſelf-ſame point individually placed, without the leaſt additional mark or variation of place, ſhall ſtand for all the twenty-four letters, and not for the ſame letter twice in ten ſheets writing; yet as eaſily and certainly read and known, as if it ſtood but for one and the ſelf-ſame letter conſtantly ſignified.

VI. *A mute and perfect Diſcourſe by Colours.*

How at a window, as far as eye can diſcover black from white, a man may hold diſcourſe with his correſpondent, without noiſe made or notice taken; being, according to occaſion given and means afforded, *ex re natâ*, and no need of proviſion beforehand; though much better if foreſeen, and means prepared for it, and a premeditated courſe taken by mutual conſent of parties.

VII. *To hold the ſame by Night.*

A way to do it by night as well as by day, though as dark as pitch is black.

VIII. *To*

VIII. *To level Cannons by Night.*

A way how to level and ſhoot cannon by night as well as by day, and as directly; without a platform or meaſures taken by day, yet by a plain and infallible rule.

IX. *A Ship-deſtroying Engine.*

An engine, portable in one's pocket, which may be carried and faſtened on the inſide of the greateſt ſhip, *tanquam aliud agens*, and at any appointed minute, though a week after, either of day or night, it ſhall irrecoverably ſink that ſhip.

X. *How to be faſtened from aloof and under Water.*

A way from a mile off to dive and faſten a like engine to any ſhip, ſo as it may punctually work the ſame effect either for time or execution.

XI. *How to prevent both.*

How to prevent and ſafeguard any ſhip from ſuch an attempt by day or night.

XII. *An unſinkable Ship.*

A way to make a ſhip not poſſible to be ſunk though ſhot an hundred times betwixt wind and water by cannon, and ſhould loſe a whole plank, yet in half an hour's time ſhould be made as fit to ſail as before.

XIII. *Falſe deſtroying Decks.*

How to make ſuch falſe decks as in a moment ſhould kill and take priſoners as many as ſhould board the ſhip, without blowing the decks up, or deſtroying them from being reducible, and in a quarter of an hour's time ſhould recover their former ſhape, and to be made fit for any employment without diſcovering the ſecret.

XIV. *Multiplied Strength in little Room.*

How to bring a force to weigh up an anchor, or to do any forcible exploit in the narroweſt or loweſt room in any ſhip, where few hands ſhall do the work of many; and many hands applicable to the ſame force, ſome ſtanding, others ſitting, and by virtue of their ſeveral helps a great force augmented in little room, as effectual as if there were ſufficient ſpace to go about with an axle-tree, and work far from the centre.

XV. *A Boat driving againſt Wind and Tide.*

A way how to make a boat work itſelf againſt wind and tide, yea both without the help of man or beaſt; yet ſo that

the

the wind or tide, though directly oppoſite, ſhall force the ſhip or boat againſt itſelf and in no point of the compaſs, but it ſhall be as effectual as if the wind were in the pupp, or the ſtream actually with the courſe it is to ſteer, according to which the oars ſhall row, and neceſſary motions work and move towards the deſired port or point of the compaſs.

XVI. *A Sea-ſailing Fort.*

How to make a ſea-caſtle or fortification cannon proof, and capable of a thouſand men, yet ſailable at pleaſure to defend a paſſage, or in an hour's time to divide itſelf into three ſhips as fit and trimmed to ſail as before; and even whilſt it is a fort or caſtle they ſhall be unanimouſly ſteered, and effectually be driven by an indifferent ſtrong wind.

XVII. *A pleaſant floating Garden.*

How to make upon the Thames a floating garden of pleaſure, with trees, flowers, banqueting-houſes, and fountains, ſtews for all kind of fiſhes, a reſerve for ſnow to keep wine in, delicate bathing-places, and the like; with muſic made with mills: and all in the midſt of the ſtream, where it is moſt rapid.

XVIII. *An Hour-glaſs Fountain.*

An artificial fountain to be turned like an hour-glaſs, by a child, in the twinkling of an eye, it holding great quantity of water, and of force ſufficient to make ſnow, ice, and thunder, with a chirping and ſinging of birds, and ſhowing of ſeveral ſhapes and effects uſual to fountains of pleaſure.

XIX. *A Coach-ſaving Engine.*

A little engine within a coach, whereby a child may ſtop it, and ſecure all perſons within it, and the coachman himſelf, though the horſes be never ſo unruly in a full career; a child being ſufficiently capable to looſen them in what poſture ſoever they ſhould have put themſelves, turning never ſo ſhort; for a child can do it in the twinkling of an eye.

XX. *A Balance Water-work.*

How to bring up water balance-wiſe, ſo that as little weight or force as will turn a balance will be only needful, more than the weight of the water within the buckets, which, counterpoiſed, empty themſelves one into the other, the uppermoſt yielding its water (how great a quantity ſoever it holds) at the ſelf-ſame time the lowermoſt taketh it in, though it be an hundred fathom high.

XXI. *A Bucket Fountain.*

How to raiſe water conſtantly, with two buckets only, day and

and night, without any other force than its own motion, using not so much as any force, wheel, or sucker, nor more pulleys than one, on which the cord or chain rolleth with a bucket fastened at each end. This, I confess, I have seen and learned of the great mathematician Claudius his studies, at Rome, he having made a present thereof unto a cardinal; and I desire not to own any other men's inventions, but if I set down any, to nominate likewise the inventor.

XXII. *An ebling and flowing River.*

To make a river in a garden to ebb and flow constantly, though twenty foot over, with a child's force, in some private room or place out of sight, and a competent distance from it.

XXIII. *An ebbing and flowing Castle-clock.*

To set a clock in a castle, the water filling the trenches about it; it shall show, by ebbing and flowing, the hours, minutes and seconds, and all the comprehensible motions of the heavens, and counterlibration of the earth, according to Copernicus.

XXIV. *A Strength-increasing Spring.*

How to increase the strength of a spring to such an height, as to shoot bumbasses, and bullets of an hundred pound weight a steeple height, and a quarter of a mile off and more, stone-bow-wise, admirable for fire-works and astonishing of besieged cities, when without warning given by noise they find themselves so forcibly and dangerously surprised.

XXV. *A double drawing Engine for Weights.*

How to make a weight that cannot take up an hundred pound, and yet shall take up two hundred pound, and at the self-same distance from the centre; and so proportionably to millions of pounds.

XXVI. *A to-and-fro Lever.*

To raise weight as well and as forcibly with the drawing back of the lever, as with the thrusting it forwards; and by that means to lose no time in motion or strength. This I saw in the arsenal at Venice.

XXVII. *A most easy Level Draught.*

A way to remove to and fro huge weights, with a most inconsiderable strength, from place to place. For example, ten ton with ten pounds, and less; the said ten pounds not to fall lower than it makes the ten ton to advance or retreat upon a level.

XXVIII. *A*

XXVIII. *A portable Bridge.*

A bridge, portable in a cart with ſix horſes, which in a few hours time may be placed over a river half a mile broad, whereon with much expedition may be tranſported horſe, foot, and cannon.

XXIX. *A moveable Fortification.*

A portable fortification able to contain five hundred fighting men, and yet in ſix hours time may be ſet up, and made cannon proof, upon the ſide of a river or paſs, with cannon mounted upon it, and as complete as a regular fortification, with half moons and counterſcarps.

XXX. *A riſing Bulwark.*

A way in one night's time to raiſe a bulwark twenty or thirty foot high, cannon proof, and cannon mounted upon it, with men to overlook, command and batter a town; for, though it contain but four pieces, they ſhall be able to diſcharge two hundred bullets each hour.

XXXI. *An approaching Blind.*

A way how ſafely and ſpeedily to make an approach to a caſtle or town wall, and over the very ditch, at noon day.

XXXII. *An univerſal Character.*

How to compoſe an univerſal character methodical and eaſy to be written, yet intelligible in any language; ſo that, if an Engliſhman write it in Engliſh, a Frenchman, Italian, Spaniard, Iriſh, Welſh, being ſcholars; yea, Grecian or Hebrean, ſhall as perfectly underſtand it in their own tongue as if they were perfect Engliſh, diſtinguiſhing the verbs from nouns, the numbers, tenſes, and caſes, as properly expreſſed in their own language as it was written in Engliſh.

XXXIII. *A Needle Alphabet.*

To write with a needle and thread, white, or any colour upon white, or any other colour, ſo that one ſtitch ſhall ſignificantly ſhow any letter, and as readily and as eaſily ſhow the one letter as the other, and fit for any language.

XXXIV. *A knotted String Alphabet.*

To write by a knotted ſilk ſtring, ſo that every knot ſhall ſignify any letter with comma, full point, or interrogation, and as legible as with pen and ink upon white paper.

XXXV. *A Fringe Alphabet.*

The like by the fringe of gloves.

XXXVI. *A Bracelet Alphabet.*

By ſtringing of bracelets.

XXXVII. *A*

XXXVII. *A Pincked Glove Alphabet.*

By pincked gloves.

XXXVIII. *A Sieve Alphabet.*

By holes in the bottom of a ſieve.

XXXIX. *A Lanthorn Alphabet.*

By a lattin or plate lanthorn.

XL. *An Alphabet by the Smell*—XLI. *Taſte*—XLII. *Touch.*

By the ſmell—by the taſte—by the touch.—By theſe three ſenſes as perfectly, diſtinctly, and unconfuſedly, yea, as readily, as by the ſight.

XLIII. *A Variation of all and each of theſe.*

How to vary each of theſe, ſo that ten thouſand may know them, and yet keep the underſtanding part from any but their correſpondent.

XLIV. *A Key-piſtol.*

To make a key of a chamber door, which to your ſight hath its wards and roſe-pipe, but paper-thick, and yet at pleaſure, in a minute of an hour, ſhall become a perfect piſtol, capable to ſhoot through a breaſt-plate, commonly of carabine-proof, with prime, powder, and ſirelock, undiſcoverable in a ſtranger's hand.

XLV. *A moſt conceited Tinder-box.*

How to light a fire and a candle at what hour of the night one awaketh, without riſing or putting one's hand out of the bed. And the ſame thing becomes a ſerviceable piſtol at pleaſure; yet by a ſtranger, not knowing the ſecret, ſeemeth but a dextrous tinder-box.

XLVI. *An artificial Bird.*

How to make an artificial bird to fly which way and as long as one pleaſeth, by or againſt the wind, ſometimes chirping, other times hovering, ſtill tending the way it is deſigned for.

XLVII. *An Hour Water-ball.*

To make a ball of any metal, which thrown into a pool or pail of water ſhall preſently riſe from the bottom, and conſtantly ſhow, by the ſuperficies of the water, the hour of the day or night, never riſing more out of the water than juſt to the minute it ſhoweth of each quarter of the hour; and if by force kept under water, yet the time is not loſt, but recovered as ſoon as it is permitted to riſe to the ſuperficies of the water.

XLVIII. *A ſcrewed Aſcent of Stairs.*

A ſcrewed aſcent, inſtead of ſtairs, with fit landing places to the beſt chambers of each ſtory, with back ſtairs within the noell of it, convenient for ſervants to paſs up and down to the inward rooms of them unſeen and private.

XLIX. *A Tobacco-tongs Engine.*

A portable engine, in way of a tobacco-tongs, whereby a man may get over a wall, or get up again being come down, finding the coaſt proving unſecure unto him.

L. *A Pocket Ladder.*

A complete light portable ladder, which taken out of one's pocket, may be by himſelf faſtened an hundred foot high to get up by from the ground.

LI. *A Rule of Gradation.*

A rule of gradation, which with eaſe and method reduceth all things to a private correſpondence, moſt uſeful for ſecret intelligence.

LII. *A myſtical Jangling of Bells.*

How to ſignify words and a perfect diſcourſe by jangling of bells of any pariſh church, or by any muſical inſtrument within hearing, in a ſeeming way of tuning it; or of an unſkilful beginner.

LIII. *An Hollowing of a Water-ſcrew.*

A way how to make hollow and cover a water-ſcrew as big and as long as one pleaſeth, in an eaſy and cheap way.

LIV. *A tranſparent Water-ſcrew.*

How to make a water-ſcrew tight and yet tranſparent, and free from breaking; but ſo clear, that one may palpably ſee the water, or any heavy thing, how and why it is mounted by turning.

LV. *A double Water-ſcrew.*

A double water-ſcrew, the innermoſt to mount the water, and the outermoſt for it to deſcend more in number of threads, and conſequently in quantity of water, though much ſhorter than the innermoſt ſcrew by which the water aſcendeth; a moſt extraordinary help for the turning of the ſcrew to make the water riſe.

LVI. *An advantageous Change of Centres.*

To provide and make that all the weights of the deſcending ſide of a wheel ſhall be perpetually further from the centre, than thoſe of the mounting ſide, and yet equal in number and

and heft to the one ſide as the other. A moſt incredible thing, if not ſeen, but tried before the late king (of bleſſed memory) in the Tower, by my directions, two extraordinary ambaſſadors accompanying his majeſty, and the duke of Richmond and duke Hamilton, with moſt of the court, attending him. The wheel was fourteen foot over, and forty weights of fifty pounds apiece. Sir William Balfour, then lieutenant of the Tower, can juſtify it, with ſeveral others. They all ſaw, that no ſooner theſe great weights paſſed the diameter-line of the lower ſide, but they hung a foot further from the centre, nor no ſooner paſſed the diameter-line of the upper ſide, but they hung a foot nearer. Be pleaſed to judge the conſequence.

LVII. *A conſtant Water-flowing and ebbing Motion.*

An ebbing and flowing water-work in two veſſels, into either of which, the water ſtanding at a level, if a globe be caſt in, inſtead of riſing it preſently ebbeth, and ſo remaineth until a like globe be caſt into the other veſſel; which the water is no ſooner ſenſible of, but that veſſel preſently ebbeth, and the other floweth, and ſo continueth ebbing and flowing until one or both of the globes be taken out, working ſome little effect beſides its own motion, without the help of any man within ſight or hearing; but if either of the globes be taken out, with ever ſo ſwift or eaſy a motion, at the very inſtant the ebbing and flowing ceaſeth; for if during the ebbing you take out the globe, the water of that veſſel preſently returneth to flow, and never ebbeth after, until the globe be returned into it, and then the motion beginneth as before.

LVIII. *An often-diſcharging Piſtol.*

How to make a piſtol to diſcharge a dozen times with one loading, and without ſo much as once new priming requiſite, or to change it out of one hand into the other, or ſtop one's horſe.

LIX. *An eſpecial Way for Carabines.*

Another way as faſt and effectual, but more proper for carabines.

LX. *A Flaſk-charger.*

A way with a flaſk appropriated unto it, which will furniſh either piſtol or carabine with a dozen charges in three minutes time, to do the whole execution of a dozen ſhots, as ſoon as one pleaſeth, proportionably.

LXI. *A Way for Muſkets.*

A third way, and particular for muſkets, without taking

them from their reſts to charge or prime, to a like execution, and as faſt as the flaſk, the muſket containing but one charge at a time.

LXII. *A Way for a Harquebuſs—a Crock.*

A way for a harquebuſs, a crock, or ſhip-muſket, fix upon a carriage, ſhooting with ſuch expedition, as without danger one may charge, level, and diſcharge them ſixty times in a minute of an hour, two or three together.

LXIII. *For Sakers and Minyons.*

A ſixth way, moſt excellent for ſakers, differing from the other, yet as ſwift.

LXIV. *For the biggeſt Cannon.*

A ſeventh, tried and approved before the late king (of ever bleſſed memory) and an hundred lords and commons, in a cannon of eight inches half quarter, to ſhoot bullets of 64 lbs. weight, and 24 lbs. of powder, twenty times in ſix minutes; ſo clear from danger, that after all were diſcharged, a pound of butter did not melt being laid upon the cannon-breech, nor the green oil diſcoloured that was firſt anointed and uſed between the barrel thereof and the engine, having never in it, nor within ſix foot, but one charge at a time.

LXV. *For a whole Side of Ship Muſkets.*

A way that one man in the cabin may govern the whole ſide of ſhip-muſkets, to the number (if need require) of 2 or 3000 ſhots.

LXVI. *For guarding ſeveral Advenues to a Town.*

A way that againſt ſeveral advenues to a fort or caſtle, one man may charge fifty cannons playing, and ſtopping when he pleaſeth, though out of ſight of the cannon.

LXVII. *For Muſketoons on Horſeback.*

A rare way likewiſe for muſketoons faſtened to the pommel of the ſaddle, ſo that a common trooper cannot miſs to charge them with twenty or thirty bullets at a time, even in full career.

"When firſt I gave my thoughts to make guns ſhoot often, I thought there had been but one only exquiſite way inventible, yet by ſeveral trials, and much charge, I have perfectly tried all theſe."

LXVIII. *A Fire Water-work.*

An admirable and moſt forcible way to drive up water by fire, not by drawing or ſucking it upwards, for that muſt be as the philoſopher calleth it, *intra ſphæram activitatis*, which is but at ſuch a diſtance. But this way hath no bounder, if the veſſels be ſtrong enough; for I have taken a piece of a

whole

whole cannon, whereof the end was burſt, and filled it three quarters full of water, ſtopping and ſcrewing up the broken end; as alſo the touch-hole; and making a conſtant fire under it, within 24 hours it burſt and made a great crack: ſo that having a way to make my veſſels ſo that they are ſtrengthened by the force within them, and the one to fill after the other. I have ſeen the water run like a conſtant fountain-ſtream forty foot high; one veſſel of water rarefied by fire, driveth up forty of cold water. And a man that tends the work is but to turn two cocks, that one veſſel of water being conſumed, another begins to force and refill with cold water, and ſo ſucceſſively, the fire being tended and kept conſtant, which the ſelf-ſame perſon may likewiſe abundantly perform in the interim between the neceſſity of turning the ſaid cocks.

LXIX. *A triangle Key.*

A way how a little triangle ſcrewed key, not weighing a ſhilling, ſhall be capable and ſtrong enough to bolt and unbolt round about a great cheſt an hundred bolts through fifty ſtaples, two in each, with a direct contrary motion, and as many more from both ſides and ends, and at the ſelf-ſame time ſhall faſten it to the place beyond a man's natural ſtrength to take it away; and in one and the ſame turn both locketh and openeth it.

LXX. *A Roſe Key.*

A key with a roſe-turning pipe, and two roſes pierced through endwiſe the bit thereof, with ſeveral handſomely-contrived wards, which may likewiſe do the ſame effects.

LXXI. *A ſquare Key with a turning Screw.*

A key perfectly ſquare, with a ſcrew turning within it, and more conceited than any of the reſt, and no heavier than the triangle ſcrewed key, and doth the ſame effects.

LXXII. *An Eſcocheon for all Locks.*

An eſcocheon to be placed before any of theſe locks with theſe properties.

1. The owner (though a woman) may with her delicate hand vary the ways of coming to open the lock ten millions of times, beyond the knowledge of the ſmith that made it, or of me who invented it.

2. If a ſtranger openeth it, it ſetteth an alarm a-going, which the ſtranger cannot ſtop from running out; and beſides, though none ſhould be within hearing, yet it catcheth his hand, as a trap doth a fox; and though far from maiming him, yet it leaveth ſuch a mark behind it, as will diſ-

cover him if ſuſpected; the eſcocheon or lock plainly ſhowing what monies he hath taken out of the box to a farthing, and how many times opened ſince the owner had been in it.

LXXIII. *A tranſmittible Gallery.*

A tranſmittible gallery over any ditch or breach in a town-wall, with a blind and parapet cannon proof.

LXXIV. *A conceited Door.*

A door whereof the turning of a key, with the help and motion of the handle, makes the hinges to be of either ſide, and to open either inward or outward, as one is to enter or to go out, or to open in half.

LXXV. *A Diſcourſe woven in Tape or Ribbon.*

How a tape or ribbon-weaver may ſet down a whole diſcourſe without knowing a letter, or interweaving any thing ſuſpicious of other ſecret than a new faſhioned ribbon.

LXXVI. *To write in the Dark.*

How to write in the dark as ſtraight as by day or candle-light.

LXXVII. *A flying Man.*

How to make a man to fly; which I have tried with a little boy of ten years old in a barn, from one end to the other, on an hay-mow.

LXXVIII. *A continually going Watch.*

A watch to go conſtantly, and yet needs no other winding from the firſt ſetting on the cord or chain, unleſs it be broken, requiring no other care from one than to be now and then conſulted with concerning the hour of the day or night; and if it be laid by a week together, it will not err much, but the oftener looked upon, the more exact it ſhoweth the time of the day or night.

LXXIX. *A total Locking of Cabinet Boxes.*

A way to lock all the boxes of a cabinet (though never ſo many) at one time which were by particular keys appropriated to each lock opened ſeverally, and independent the one of the other, as much as concerneth the opening of them, and by theſe means cannot be left opened unawares.

LXXX. *Light Piſtol Barrels.*

How to make a piſtol-barrel no thicker than a ſhilling, and yet able to endure a muſket proof of powder and bullet.

LXXXI. *A Comb-conveyance for Letters.*

A comb-conveyance carrying of letters without ſuſpicion,

the head being opened with a needle-ſcrew drawing a ſpring towards them; the comb being made but after an uſual form carried in one's pocket.

LXXXII. *A Knife, Spoon, or Fork Conveyance.*

A knife, ſpoon, or fork, in an uſual portable caſe, may have the like conveyances in their handles.

LXXXIII. *A Raſping Mill.*

A raſping-mill for hartſhorn, whereby a child may do the work of half a dozen men, commonly taken up with that work.

LXXXIV. *An Arithmetical Inſtrument.*

An inſtrument whereby perſons ignorant in arithmetic may perfectly obſerve numerations and ſubſtractions of all ſums and fractions.

LXXXV. *An untoothſome Pear.*

A little ball, made in the ſhape of plum or pear, being dextrouſly conveyed or forced into a body's mouth, ſhall preſently ſhoot forth ſuch and ſo many bolts of each ſide and at both ends, as without the owner's key can neither be opened or filed off, being made of tempered ſteel, and as effectually locked as an iron cheſt.

LXXXVI. *An impriſoning Chair.*

A chair made *à-la-mode*, and yet a ſtranger being perſuaded to ſit down in it, ſhall have immediately his arms and thighs locked up beyond his own power to looſen them.

LXXXVII. *A Candle-mold.*

A braſs mold to caſt candles, in which a man may make 500 dozen in a day, and add an ingredient to the tallow which will make it cheaper, and yet ſo that the candles ſhall look whiter and laſt longer.

LXXXVIII. *A Brazen Head.*

How to make a brazen or ſtone head in the midſt of a great field or garden, ſo artificial and natural, that though a man ſpeak never ſo ſoftly, and even whiſpers into the ear thereof, it will preſently open its mouth, and reſolve the queſtion in French, Latin, Welſh, Iriſh, or Engliſh, in good terms uttering it out of his mouth, and then ſhut it until the next queſtion be aſked.

LXXXIX. *Primero Gloves.*

White ſilk knotted in the fingers of a pair of white gloves, and ſo contrived without ſuſpicion, that playing at primero at cards, one may, without clogging his memory, keep reckoning of all ſixes, ſevens, and aces, which he hath diſcarded.

XC. *A Dicing Box.*

A moſt dexterous dicing box, with holes tranſparent, after the uſual faſhion, with a device ſo dexterous, that with a knock of it againſt the table, the four good dice are faſtened, and it looſeneth four falſe dice made fit for his purpoſe.

XCI. *An artificial Ring-horſe.*

An artificial horſe, with faddle and capariſons fit for running at the ring, on which a man being mounted, with his lance in his hand, he can at pleaſure make him ſtart, and ſwiftly to run his career, uſing the decent poſture with bon grace, may take the ring as handſomely, and running as ſwiftly, as if he rode upon a barbe.

XCII. *A Gravel Engine.*

A ſcrew made like a water-ſcrew, but the bottom made of iron plate ſpadewiſe, which at the ſide of a boat emptieth the mud of a pond, or raiſeth gravel.

XCIII. *A Ship-raiſing Engine.*

An engine whereby one man may take out of the water a ſhip of 500 tons, ſo that it may be caulked, trimmed, and repaired, without need of the uſual way of ſtocks, and as eaſily let it down again.

XCIV. *A Pocket Engine to open any Door.*

A little engine, portable in one's pocket, which placed to any door, without any noiſe but one crack, openeth any door or gate.

XCV. *A double Croſs-bow.*

A double croſs-bow, neat, handſome, and ſtrong, to ſhoot two arrows, either together or one after the other, ſo immediately that a deer cannot run two ſteps but, if he miſs of one arrow, he may be reached with the other, whether the deer run forward, ſideward, or ſtart backward.

XCVI. *A Way for Sea Banks.*

A way to make a ſea bank ſo firm and geometrically ſtrong, ſo that a ſtream can have no power over it; excellent likewiſe to ſave the pillar of a bridge, being far cheaper and ſtronger than ſtone-walls.

XCVII. *A perſpective Inſtrument.*

An inſtrument whereby an ignorant perſon may take any thing in perſpective, as juſtly and more than the ſkilfulleſt painter can do by his eye.

XCVIII. *A ſemi-omnipotent Engine.*

An engine ſo contrived, that working the *primum mobile* forward or backward, upward or downward, circularly or cornerwiſe,

cornerwiſe, to and fro, ſtraight, upright or downright, yet the pretended operation continueth, and advanceth none of the motions above mentioned, hindering, much leſs ſtopping the other; but unanimouſly, and with harmony, agreeing, they all augment and contribute ſtrength unto the intended work and operation: and therefore I call this a *ſemi-omnipotent engine*, and do intend that a model thereof be buried with me.

XCIX. *A moſt admirable Way to raiſe Weights.*

How to make one pound weight to raiſe an hundred as high as one pound falleth, and yet the hundred pound deſcending, doth what nothing leſs than one hundred pounds can effect.

C. *A ſtupendous Water-work.*

Upon ſo potent a help as theſe two laſt-mentioned inventions, a water-work is, by many years experience and labour, ſo advantageouſly by me contrived, that a child's force bringeth up, an hundred foot high, an incredible quantity of water, even two foot diameter, ſo naturally, that the work will not be heard even into the next room; and with ſo great eaſe and geometrical ſymmetry, that though it work day and night from one end of the year to the other, it will not require forty ſhillings reparation to the whole engine, nor hinder one's day-work, and I may boldly call it the moſt ſtupendous work in the whole world: not only with little charge to drain all ſorts of mines, and furniſh cities with water, though never ſo high ſeated, as well to keep them ſweet, running through ſeveral ſtreets, and ſo performing the work of ſcavingers, as well as furniſhing the inhabitants with ſufficient water for their private occaſions; but likewiſe ſupplying rivers with ſufficient to maintain and make them portable from town to town, and for the bettering of lands all the way it runs; with many more advantageous and yet greater effects of profit, admiration, and conſequence. So that deſervedly I deem this invention to crown my labours, to reward my expenſes, and make my thoughts acquieſce in way of further inventions: this making up the whole century, and preventing any further trouble to the reader for the preſent, meaning to leave to poſterity a book, wherein under each of theſe heads the means to put in execution and viſible trial all and every of theſe inventions, with the ſhape and form of all things belonging to them, ſhall be printed by braſs plates.

In bonum publicum, et majorem Dei gloriam.

XII. *Ob-*

XII. *Observations on the Magnetic Property of Cobalt and Nickel. Extracted from a Memoir read in the French National Institute by* B. G. Sage, *Director of the first School of Mines* *.

HAVING resolved to repeat the experiments by which Klaproth, Taffaert, and Haüy determined that cobalt and nickel are susceptible of acquiring magnetic properties, I proceeded to refine these semi-metallic substances by means which I shall here describe, and by which I extracted from cobalt the arsenic, iron, bismuth, and silver; substances with which it is almost always combined.

Having disengaged the arsenic, by torrefaction, from cobalt ore of a whitish gray colour, I mixed pounded charcoal with the oxide or brownish calx which remained in the test. I then torrefied it a second time, in order to disengage the arsenical acid.

I then mixed this oxide of cobalt with two parts of vitreous flux † and a little pulverized charcoal. I fused this mixture, and obtained a button of cobalt, which I again fused with borax: after these two fusions the cobalt exhibited a homogeneous grain, though it contained iron, bismuth ‡, and particularly silver, in the ratio of nearly a fourth.

I pulverized this cobalt, and, having mixed it with an equal part of sal-ammoniac, subjected it to distillation: caustic volatile alkali was disengaged, and there was afterwards sublimed in the neck of the retort sal-ammoniac coloured yellow by a little iron. The next sublimated portion had a pale green tint, a colour which arose from the cobalt. The retort having been kept in a red heat for an hour, salt or muriate of bismuth was sublimated in white foliaceous crystals. This salt, when put into distilled water, was decomposed, and rendered it milky.

I mixed the muriate of cobalt which remained in the retort with sal-ammoniac, and proceeded to distillation: the sal-ammoniac, which was sublimated, contained neither iron nor muriate of bismuth, and was coloured of a delicate green by a little cobalt.

I fused the salt or muriate of cobalt which remained in the retort with equal parts of black flux and a fiftieth of pulverized charcoal: in this alkaline flux I found the cobalt

* From the *Journal de Physique*, Floreal, an. 10.

† Composed of equal parts of white glass and fixed alkali.

‡ If this metal be in the ratio of a third, it diffuses itself around the button of cobalt, and incloses it as if it were set in it.

and

and ſilver in contact with each other, but without adheſion*.

It was this purified cobalt which I employed to diſcover whether it was ſuſceptible of acquiring polarity by the magnet; and to aſcertain it fully, I begged our colleague Coulomb, who is ſo familiar with theſe experiments, to have the goodneſs to aſſiſt me. I carried to him the ingots of purified cobalt and nickel, which he endeavoured to magnetize; but, as they did not indicate any magnetic property in a ſatisfactory manner, he deſired me to fuſe them into thin plates, which I accordingly did. They were then eaſily magnetized, and, being ſuſpended merely by a ſilk thread, indicated the poles in a perfect manner. Theſe facts prove that theſe two ſemi-metallic ſubſtances have, as well as iron, the faculty of retaining the magnetic fluid introduced into their pores.

XIII. *Experiments and Obſervations on the Heat and Cold produced by the mechanical Condenſation and Rarefaction of Air.* By JOHN DALTON†.

IF a thermometer be incloſed in a receiver and the air ſuddenly condenſed, the thermometer riſes a few degrees above the temperature of the atmoſphere; and if the air be exhauſted from a receiver incloſing a thermometer, the mercury ſinks a few degrees immediately; but in both caſes after ſome time it reſumes its former ſtation. Theſe facts are well known to philoſophers of the preſent age, but they do not all agree in the explanation of them. Thinking the ſubject worthy of elucidation, I was induced to inſtitute a ſeries of experiments for the purpoſe, which I apprehend have led to a clear demonſtration of the cauſe of the phænomena, and moreover make the facts themſelves appear in a ſomewhat different point of view from what they are ſeen in at the firſt moment.

One circumſtance is very remarkable, that whether the mercury riſes or falls in theſe inſtances, it is done very rapidly; whereas in the open air, if a thermometer be only two or three degrees above or below the temperature, it moves very ſlowly. This ſeems to have ſuggeſted to every one the idea that the elaſticity of the glaſs bulb of the thermometer has a principal ſhare in producing the effect, by

* I purified the nickel from the iron it contained by ſublimation with ſal-ammoniac, and reduced it by fuſing it with black flux.

† From the *Manchester Memoirs*, vol. v. part 2.

cauſing

cauſing the bulb to yield a little to the preſſure of the air. It has however been found upon trial that the ſame effects take place whether the thermometer is ſealed or not. My experiments accord with this, having made a thermometer and left it unſealed for the expreſs purpoſe: in all the experiments with condenſed and rarefied air, there was no ſenſible difference obſerved to ariſe from the inequality of preſſure on the external and internal ſurfaces of the bulbs, the ſealed and open thermometers varying the ſame in kind and alſo in degree, except from circumſtances to be noticed hereafter.

It being certain then that a real change of temperature takes place, it remained to determine the quantity and manner of that change. Having choſen a ſmall and conſequently ſenſible thermometer, with a ſcale of degrees ſufficiently large to admit of diſtinguiſhing one-tenth of a degree, I proceeded to aſcertain ſeveral facts experimentally.

Exp. I. Took a receiver, the capacity of which was about 120 cubic inches, and ſuſpended the thermometer with its clear bulb in the central part of it; then letting the whole acquire the temperature of the room, which was without a fire, I exhauſted the air and afterwards reſtored it, marking the effects upon the thermometer. The medium of ſeveral trials nearly agreeing with each other was as under:

The thermometer in the air of the room ſtood at - 36°.8
——————— ſunk upon exhauſtion to - 34 .7
——————— roſe when the air was reſtored to 38 .9

The ſuddenneſs of the fall and riſe puzzled me moſt: after reflecting upon it for ſome time, I conjectured that the real change of temperature of the air or medium was much greater than the thermometer indicated, but that the inequality exiſted only for a few ſeconds of time, becauſe the receiver, &c. immediately impart heat to, or abſtract it from, ſo ſmall a quantity of air as 120 cubic inches, which are only equal to 40 grains in weight. The phænomena of the thermometer ſeemed very well to accord with the ſuppoſition of great heat or cold acting upon it for a few ſeconds only.

Exp. II. Purſuing this idea, I imagined that if two thermometers whoſe bulbs were very unequal in magnitude were incloſed together, the ſmaller bulb ought to give the greater variation: accordingly I incloſed two, the diameters of their bulbs being .35 and .65 of an inch reſpectively; and having exhauſted the air and reſtored it again repeatedly in ſucceſſion, and found a mean of the variations, that of the ſmall bulb was 2°.8, and that of the large, 2°.2.

Exp. III. Repeated the exhauſtion with the ſmall thermometer incloſed in three different circumſtances ſucceſſively:

ſively: 1ſt, with the bulb in the centre of the receiver; 2d, with the bulb reſting on the wet leather of the plate; and, 3d, with the bulb reſting againſt the ſide of the receiver.

1ſt caſe; reduced by exhauſtion	-	2°.45
2d caſe - - -	-	2 .15
3d caſe - - -	-	1 .2
1ſt caſe; raiſed by reſtoring the air	-	4 .05
2d caſe - - -	-	2 .25
3d caſe - - -	-	2 .8

Exp. IV. Incloſed a wine glaſs with about a cubic inch of water in it, containing the bulb of a thermometer, in a receiver; and, exhauſting the air, the thermometer ſunk half a degree ſuddenly, and then continued ſtationary; upon reſtoring the air, it ſuddenly roſe half a degree.

All theſe experiments confirmed my conjecture of a much greater degree of heat and cold being produced in theſe caſes than the thermometer points out, but that its continuance is ſo ſhort as not to effect a material change in the temperature of the mercury. The following experiments were made to aſcertain what may be the *real* degree of heat and cold generated in thoſe operations.

Exp. V. The ſame receiver and ſmall thermometer as above being uſed, I found the exhauſtion was effected by working the pump one minute. The thermometer ſunk nearly 2° in the firſt half minute, and the remainder, a few tenths of a degree, in the latter half minute. The operation being ſtopped, and things remaining in the ſame ſtate, it required ſome minutes of time before the thermometer recovered one degree of the heat loſt. Upon opening the cock, the receiver filled with air in five ſeconds, and the greateſt velocity of the riſing mercury was about the end of that time. The riſing continued for 30 or 40 ſeconds from its commencement, but 3-4ths of the effect were produced in the firſt ten ſeconds. The greateſt velocity of the riſing mercury is 1° in $3\frac{1}{2}$ ſeconds. After the thermometer had attained its utmoſt height, it began to fall again at the rate of $\frac{1}{10}$th of a degree in a minute.

Exp. VI. Took the ſame thermometer and heated it to 50° above the temperature of the air; then let it be cooled by the medium of air, and it began to fall at the rate of 1° in $3\frac{1}{2}$ ſeconds.

The two laſt experiments ſeem to prove that when air is let in to the receiver in the ordinary way, *an increaſe of temperature of 50° is produced in the medium within the receiver for* $3\frac{1}{2}$ *ſeconds.* This high temperature is reduced *in a few*

few seconds, by the receiver and ſurrounding bodies, to their own temperature.

Exp. VII. *On condenſed Air.*—Took a large ſpherical glaſs receiver, the capacity of which was ſomething more than twice that of the former (above one gallon), and ſuſpended a thermometer in the centre of it, of a larger bulb than that before uſed; the receiver had a braſs cap and ſtop-cock adapted to it: then doubled the denſity of the air within it by a condenſer. The thermometer roſe 2° or more. Let out the air ſuddenly, and the thermometer immediately ſunk each time from 3° to 3°.5; at the ſame time an exceedingly denſe miſt was produced in the receiver, which ſoon ſubſided.

Suſpecting that aqueous vapour, which always exiſts in the atmoſphere, and is liable to aſſume the liquid or aërial form according to circumſtances, might be the principal agent in the production of heat and cold by condenſation and rarefaction, I thought that an increaſe of it might produce a greater effect, and that cold air, which contains leſs vapour, might have a leſs effect. The reverſe however was the fact, as appears by the following

Exp. VIII. and IX. In a cold morning laſt winter when the air was clear and the thermometer without ſtood at 20°, I took the receiver and condenſer into the open air, and let them ſtand for 15 minutes to acquire its temperature; then repeatedly condenſed the air to a double denſity, and ſuddenly liberated it again. On a medium of five trials, the mercury fell 3°.3 on opening the cock. The vapour precipitated was whiter than uſual, and not nearly ſo denſe.

Again, took the receiver and condenſer into a dyer's ſtove where the temperature was about 100°, and the air abounded with vapour in a tranſparent ſtate: after ſome time, condenſed the air and liberated it as before, when on a medium of five trials the mercury ſunk only 3°, and a very copious miſt was precipitated, ſo denſe that one could but juſt diſtinguiſh the degree of the thermometer through it.

Theſe experiments ſhow that the greater the quantity of vapour condenſed, the leſs is the change of temperature; and that conſequently, if air was entirely free from vapour, the change of temperature would be a maximum. Indeed this is clearly conſiſtent with the known law, that, when vapour is condenſed, heat is given out. Any proceſs to cool the air muſt be retarded by the condenſation of part of the vapour it contains. Suppoſe, for inſtance, that a portion of the atmoſphere contained $\frac{1}{70}$th of its weight of aqueous vapour, and that $\frac{3}{5}$ths of this vapour were condenſed by 50° of cold; that is,

is, $\frac{1}{10}$ th of the whole elaſtic maſs was converted into water; then the heat given out would be ſufficient to raiſe the temperature of the remaining maſs of air and vapour 6 or 8°; which ſufficiently accounts for the ſmall difference obſerved in the reſults upon warm vapoury air and cold dry air. Hence vapour, far from producing the change of temperature in queſtion, tends to diminiſh the effect.

If any doubt remained with me reſpecting the *real* change of temperature that takes place in the operations related above, it was completely removed by the reſults of the two following experiments.

Exp. X. Incloſed a ſmall graduated glaſs tube, of $\frac{1}{15}$ th of an inch internal diameter, and ten inches long, with a ſhort column of mercury in it, in the large receiver; the tube was ſealed at one end and open at the other, ſo that a portion of air of given capacity was confined by the mercurial column, which was near the open end of the tube, and ſubject to riſe or fall by any variation of elaſticity of the air on either ſide, being a proper manometer: then doubled the denſity of the air in the receiver, and, opening the ſtop-cock, the mercurial column ſoon ran up to its former ſtation; but inſtantly turning the cock again, the mercurial column returned or fell down gradually for five or ten ſeconds, to the amount of nearly $\frac{1}{10}$th of the whole aërial column, and then became ſtationary. Again opening the cock, a quantity of air ruſhed out, and the mercury reſumed its original ſtation. Theſe effects were always the ſame, on a repetition of the experiment.

Exp. XI. Let the mercurial column of the manometer down by a wire to $\frac{1}{4}$th of the length of the tube from the ſealed end; then exhauſted $\frac{3}{4}$ths of the air from the receiver, which was ſeen by the mercury riſing to the top of the tube; and upon opening the cock the mercury fell to its former ſtation, but then ſuddenly turning the cock, the mercury gradually roſe, for the ſpace of five or ten ſeconds, to *more* than $\frac{1}{10}$th of its original height above the ſtationary point, and remained there till the cock was opened; after which it reſumed its proper ſtation.

The phænomena in the two laſt experiments can be explained only on the following principle:—The air in the receiver and in the manometer is ſubject to a like degree of rarefaction and condenſation in thoſe experiments, or very nearly ſo. When the equilibrium of heat in the air is diſturbed by the operations of condenſation and rarefaction, it is reſtored in the manometer inſtantly by reaſon of the contiguity of the glaſs to the air; but in the large receiver it requires

quires a ſenſible time of ten ſeconds or more to reſtore the equilibrium throughout the whole internal capacity. It is this reſtoration that increaſes or diminiſhes the elaſticity of the air confined in the receiver, and thereby cauſes the retrogradation of the mercurial column. Now I have found by former experiments that a change of 50° in temperature effects a change of $\frac{1}{10}$th nearly, in the capacity or bulk of air. It follows therefore that in the caſe of reſtoring the equilibrium in condenſed air, about 50° of cold is produced; and in letting in air to an exhauſted receiver, ſomething more than 50° of heat is produced. The ſmall difference ſeems to ariſe from this, that the condenſation of vapour in the former caſe diminiſhes the effect, and in the latter, if any there be, increaſes the effect, that would ariſe from operating upon purely dry air.

The experiments and obſervations hitherto related go principally to aſcertain facts without any reference to the theory of them: this, however, may be given in a few words, and is the ſame that is aſcribed to Mr. Lambert by Meſſrs. Sauſſure and Pictet, and by them adopted. He conceives that a vacuum has its proper capacity for heat, the ſame as air, or any other ſubſtance; and that the capacity of a vacuum for heat is leſs than that of an equal volume of atmoſpherical air; alſo that the denſer air is, the leſs is its capacity for heat: upon theſe principles the phænomena are eaſily referable to that claſs of chemical facts where heat and cold are generated by the mixture of two different bodies. If this theory be right, and I think there is little doubt of it, we may hence be led into a train of experiments, by which the abſolute capacity of a vacuum for heat may be determined; and likewiſe the capacities of the different gaſes for heat, by a method wholly new: but this muſt be left to future inveſtigation.

XIV. *Some Account of Dr.* OLBERS, *the celebrated Aſtronomer.*

WILLIAM OLBERS, M. D. and member of different learned ſocieties, was born on the 11th of October 1758, at Arbergen, a village in the duchy of Bremen, where his father was a clergyman. His father having been promoted to a living in Bremen in 1760, young Olbers received his education in that city; but in 1772 he loſt his father, who, beſides being a man of great general learning, was a good mathematician, and had a great attachment to

aſtronomy. About the ſame period young Olbers, then in his 14th year, conceived at once a great taſte for that ſcience. During an evening walk in the month of Auguſt, having obſerved the Pleiades or ſeven ſtars, he became very deſirous of knowing to what conſtellation they belonged. He therefore purchaſed ſome charts and books, and began to ſtudy aſtronomy with the greateſt diligence. He read with the utmoſt avidity every aſtronomical work he was able to procure, and in a few months made himſelf acquainted with all the conſtellations.

He, however, ſoon obſerved, that without a knowledge of the mathematics it would be impoſſible for him to be an aſtronomer, or to underſtand the neceſſary operations: he therefore applied to the mathematics, and devoted all his leiſure time to the ſtudy of theſe ſciences. In the year 1777, when a ſtudent of medicine at the univerſity of Göttingen, he had made himſelf maſter of every thing that could be learned from Wolf's Elements, and had read alſo a conſiderable part of the works of Euler and Lambert.

At Göttingen he had the good fortune to ſtudy mathematics under the celebrated Käſtner, whoſe lectures he attended. The method to which that eminent maſter accuſtomed his ſcholars was excellent; and Dr. Olbers conſiders himſelf indebted to him for what he has hitherto been able to do in regard to the ſolution of difficult problems. In conſequence of Käſtner's well-known readineſs to promote the progreſs of his pupils, Dr. Olbers had free acceſs to his extenſive library, and alſo to the obſervatory of which Käſtner was then director. The ſtudy of medicine, however, which was the principal object of his attention, and which he purſued with a ſucceſs equal to his zeal, allowed him very little time for the ſtudy of practical aſtronomy.

In the year 1779 he obſerved at Göttingen, and calculated, the firſt comet. An account of this labour was publiſhed by Käſtner in the Berlin Aſtronomical Calendar for the year 1782, and in the *Göttinger Anzeigen* of May 31, 1799; where it is mentioned that Olbers made his conſtruction one night while attending a patient. Käſtner here obſerves, with great juſtice, that under ſuch circumſtances the orbit of a comet could hardly be determined. But it was afterwards ſeen that Olbers's determination of this orbit correſponded with the moſt accurate elements of the comet which were calculated. Since that period the aſtronomy of comets has been his favourite ſtudy; and how much he has diſtinguiſhed himſelf in this department, and how much he has enlarged the theory, is ſeen by his new method of calculating the orbit of a comet

from obſervations, which was publiſhed, with a preface by the editor, at Weimar, in the year 1797.

Newton himſelf conſidered the calculation of the orbit of a comet as exceedingly difficult, and for this reaſon he calls the problem *longè difficillimum*. The greateſt and moſt ingenious mathematicians of the laſt century employed their talents, with various ſucceſs, on this difficult ſubject; ſuch as La Caille, Euler, La Grange, Lambert, Boſcovich, Du Sejour, Condorcet, Hennert, Tempelhof, Laplace, &c.: all the reſources of genius and all the formulæ of the higher analyſis have been tried; but none of the methods deviſed can be ſimpler, and at the ſame time more elegant, than that of Dr. Olbers. It can indeed be ſaid, that the whole was effected by his own genius; for the conciſeneſs and eaſineſs of his method are chiefly founded on ſome happy ideas, and on a ſuppoſition which approaches very near the truth. But it required no little ingenuity and practice in calculation to apply theſe ideas to the ſolution of the problem.

In the year 1780 he wrote his inaugural diſſertation, *De Oculi Mutationibus internis*; that is, on the Method in which the Eye changes to ſee diſtinctly near and diſtant Objects. Moſt phyſiologiſts have adopted his theory on this ſubject; and it has lately been placed beyond all doubt by Ramſden's and Home's experiments, publiſhed in the Tranſactions of the Royal Society.

From Göttingen Olbers proceeded to Vienna, in 1781, to acquire a more extenſive knowledge of medicine under Stoll, Quarin, Störk, and other eminent maſters. Recommendations which he carried with him from Käſtner procured him a favourable reception from father Hell the aſtronomer, and from many of the Vienna literati: but he could not turn it to much advantage, as his application to the principal object of his ſtudy, and attendance at the hoſpitals, left him very little leiſure for aſtronomy. He was the firſt, however, who obſerved the Georgian planet, or Uranus, on the 17th of Auguſt of the above year: on the 19th he perceived its motion; and on that account entered into a more intimate friendſhip with father Hell, as this new planet had not then been ſeen from the Imperial obſervatory. He obſerved it at Vienna till the end of September; and, under the erroneous opinion of its being a comet, calculated its orbit in a parabola.

Between the years 1785 and 1788, much was expected from a comet which had appeared in 1532 and 1661, and which it was ſuppoſed would return about the year 1789. Some aſtronomers ſpoke of this expected phænomenon with the ſame confidence as if it had been an eclipſe of the ſun,

ſun, or an occultation of a fixed ſtar. Dr. Olbers was the firſt who proved, in 1787, that the comets of 1532 and 1661 were totally different; conſequently, that neither of them could be expected in the year 1789. Aſtronomy, therefore, is indebted to Dr. Olbers for having cleared up this point of ſo much importance. He ſhowed how uncertain the return of theſe comets is; and that it is no fault in the exalted ſcience of aſtronomy, if predictions, which aſtronomers ought never to have ventured to make, are not accompliſhed.

From Vienna Dr. Olbers proceeded to Prague and Dreſden, and returned thence to Bremen, where he ſettled as a phyſician, and where he ſoon acquired the confidence of his fellow-citizens, both on account of his ſucceſsful practice and of the integrity and affability of his character. Since that time aſtronomy has been only the amuſement of his leiſure hours, or a ſort of recreation, to relieve and unbend the mind after the fatigue of his profeſſional duties.

We ſhall add to this ſhort ſketch, that Dr. Olbers lately diſcovered another planet, or, perhaps, comet, for the point ſeems not yet determined, of which ſome account was given in the laſt two numbers of the Philoſophical Magazine.

XV. *Experiments on Charcoal.* By CLEMENT *and* DESORMES *.

IT is generally believed that the charcoal obtained by the decompoſition of organic matters ſtill contains, notwithſtanding the action of the ſtrongeſt heat to which it can be ſubjected, ſome remains of the volatile principles to which it was united.

This opinion is founded upon this circumſtance, that by the combuſtion of charcoal water is ſometimes obtained, which ſeems to prove the preſence of hydrogen; and that to form carbonic acid with charcoal leſs oxygen is required than with the diamond; which might induce a belief that ſome of it exiſted already in the charcoal.

The memoir publiſhed by us in the 115th number of the *Annales de Chimie*, and of which the reſults are nearly the ſame as thoſe obtained by Mr. Cruikſhank, announces the gaſeous oxide of carbon as free from hydrogen.

Several chemiſts, convinced of the preſence of hydrogen in charcoal, have ſuppoſed that this gas is a triple combination of carbon, oxygen, and hydrogen, and that its inflammability ariſes from the laſt-mentioned principle.

* From the *Annales de Chimie*, No. 125.

It appeared to us of importance to make some experiments on this subject, and we proposed the following questions:

Does hydrogen exist in charcoal when properly made? Are the various kinds of charcoal indebted for their differences to the quantities of oxygen which they contain?

We employed two methods to come to the solution of these problems: the action of oxygen, and that of sulphur.

First Method.

Action of Oxygen.

In our memoir on the gaseous oxide of carbon we gave an account of experiments on the combustion of charcoal in close vessels in which no water was deposited. It is, however, possible that some was produced, but that it became dissolved in the carbonic acid gas, in which a great dissolving power is generally observed.

In repeating the combustion of different kinds of charcoal properly made, but of which some remained exposed to the air, we remarked that the latter suffered a great deal of water to evaporate merely by the action of the heat, and that during their combustion it was not produced in sufficient quantity to be deposited. Those which had been carefully protected from the action of humidity exhibited no traces of it.

This proved to us that the water observed during the combustion of charcoal previously existed, and that it had been taken up by that substance, the hygrometric property of which, long known, has been confirmed by C. Guyton in the *Encyclopédie Méthodique.*

We again assured ourselves that charcoal of white wood well made*, weighing 4 grammes, by remaining exposed to the atmosphere even during dry weather, increased in weight 0·2 grammes. When heated, the water is expelled; which may be weighed, and which forms more than three-fourths of that augmentation. The remainder is air, which may be disengaged either by heat or by exposure of the charcoal in a vacuum. It may be readily conceived that these phænomena, which depend on the state of the atmosphere, the texture of the charcoal, and the time of its exposure to the air, must be exceedingly variable.

It is then certain that, if water is produced in the combustion of charcoal, it can exist only in the state of vapour in the gases which result from it.

It became a matter of importance to know what quantity of water these gases might contain. M. de Saussure

* We consider charcoal to be so, when, after a first carbonization, it has been exposed for an hour to the action of a strong furnace.

 announces,

announces *, that, the temperature and preſſure being equal, atmoſpheric air, hydrogen and carbonic acid gas, when moiſt affect the hair hygrometer in the ſame manner; but as this inſtrument indicates only the degree of ſaturation, and not the quantity of water, we thought it our duty to make ſome experiments for the purpoſe of aſcertaining this quantity.

The property which concrete muriate of lime has to take moiſture from the gaſes without altering them, induced us to make choice of it as the means of deſiccation.

We made uſe of the apparatus generally employed. It conſiſts of a glaſs tube containing the concrete muriate of lime, the weight of which is known, and through which the gas is made to paſs. In order to be certain of their complete ſaturation, we made them paſs through a jar filled with water, and placed immediately before the muriate of lime, the temperature of which was the ſame as that of the atmoſphere and of the gaſes. It was always 12 or 13 degrees of the centigrade thermometer, and the preſſure from 762 to 765 millimetres: the other circumſtances were alſo as equal as poſſible.

The following is a table of the deſiccations which we made:

Gaſes deſiccated.	Water depoſited by 36 Litres.	Water which would be depoſited by a Cubic Foot.	
	Grammes.	Grammes.	Grains.
Atmoſpheric Air	0·33	0·313	5·89
Oxygen Gas -	0·34	0·323	6·08
Hydrogen - -	0·34	0·323	6·08
Azote - - -	0·33	0·313	5·89
Carbonic Acid	0·33	0·313	5·89

The carbonic acid, paſſing through the flaſk of water deſtined to moiſten it as much as poſſible, would have been there diſſolved; but we had previouſly ſaturated it, ſo that there really paſſed upon the muriate of lime as much of that gas as of the others.

It is here ſeen that the quantities of water depoſited by each kind of gas were nearly the ſame, and the differences can be aſcribed only to the unavoidable imperfection of the proceſs. Thus it is certain that equal volumes of very different gaſes depoſit the ſame quantity of water.

It remained to know whether the quantities of water which cannot be taken from gaſes by deſiccation are equal; but it was almoſt impoſſible to aſcertain this point by a

* *Eſſai ſur l'Hygrometrie*, chap. ix. of the ſecond eſſay.

direct experiment, since the gases cannot be obtained perfectly dry.

From analogy we were inclined to think, that if the gases absolutely contained the same quantity of water, they ought also to contain equal quantities of the liquids which are volatilized by their contact, such as alcohol and ether.

The action of the elastic fluids on the latter being very great, it was easy to form an exact opinion of it. We therefore made experiments, from which it results, that, temperature, pressure, and other circumstances, being the same, all the gases of which we have here spoken, hydrogen as well as the carbonic acid, equally favour the evaporation of ether; that is to say, that in equal spaces occupied by any gas whatever, the same quantity of this liquid may be there reduced to the elastic state, and produce the same expansion. The case is the same with alcohol, but the quantity evaporated is much less than that of ether *.

The nature of the gas, then, has no influence on the property which they have of vaporizing ether and alcohol, as it depends only on the temperature and pressure. It is probable that the case is the same with the evaporation of water. If it were possible, indeed, to exercise on the ethereal or alcoholized gases an action similar to that of the muriate of lime on humid gases; that is to say, if the ether or alcohol could be taken away by similar means, they might be equally deprived of it; but, as we took from the gases the same quantity of water, there is great reason to presume that it is absolutely the same.

This being the case, it appears to us that if well made charcoal, not moist, be burned with dried oxygen, and if the gas produced by the combustion should not contain more water than what the absorbing salt had left in the oxygen before its being employed; that is to say, if it should pass upon a similar quantity of salt without augmenting its weight, we should be almost certain that the combustion of charcoal would produce no water: we therefore made the following experiment:

Into a very long glass tube placed upon a small furnace we introduced 4·50 grammes of charcoal of common wood heated in a furnace for an hour, and not yet cooled. To the extremities of the tube we adjusted two others containing the same quantity of muriate of lime: the latter were im-

* The interesting phænomena exhibited by the action of gases on the liquids induced us to make experiments, which we shall give an account of in another memoir.

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merſed in a mixture of ice and marine ſalt kept conſtantly at 7 or 8 degrees below zero of the centigrade thermometer. To one of them was adapted an empty bladder, and to the other a ſecond containing 2 litres of oxygen.

The great tube being heated, at the place where the charcoal was the gas was made to paſs; and, when the combuſtion was completed, a ſingle atom of water was not depoſited. The tube containing the muriate of lime, which had traverſed the oxygen before it was employed, having been weighed, was found to be increaſed 0·13 grammes; that is, 0·02 more than it ought to have been according to the above table of deſiccations; which aroſe from the cold experienced by the gas. The muriate of lime traverſed by the product of the combuſtion, which ought to have contained water, was not increaſed more than 0·02 grammes. This was ſtill owing to the moiſture taken by the charcoal from the atmoſphere at the time of its introduction into the tube. But, if we ſhould chooſe to believe that this quantity was produced by the combuſtion, as it contained only 0·003 grammes of hydrogen, ariſing from 4·50 grammes of charcoal, there would exiſt in 100 grammes but 0·065 grammes; that is to ſay, $\frac{1}{1507}$, a quantity inappreciable.

C. Berthollet, in a letter printed in the *Bibliothèque Britannique**, fixes at 0.0902 grammes, or 1·7 grain, the hydrogen contained in 1·9683 litres, or 100 cubic inches of inflammable gas, ariſing from the reduction of the oxide of zinc by charcoal. But this quantity of gaſeous oxide of carbon weighs nearly 2·278 grammes, and contains 1·139 grammes of charcoal, and as much oxygen. This charcoal ought to contain, therefore, the 0·0902 grammes of hydrogen; that is to ſay, in 100 parts there ought to be 7·91 of hydrogen. C. Berthollet, then, has fixed higher than is indicated by experiment the quantity of hydrogen contained in carbonic acid gas, and conſequently in charcoal. We have, indeed, ſeen that we can ſuppoſe in the latter body at moſt 0·065 per cent.

This experiment, made with the greateſt exactneſs poſſible, ſtill proves that 100 parts of carbonic acid conſiſt nearly of 28 parts of carbon and 72 of oxygen—a reſult given by the celebrated Lavoiſier; and if he obtained water in that combuſtion, it ought not to occaſion any error in the fractions of the reſult, its exiſtence being, as we have already ſaid, anterior to the act of combuſtion.

Being deſirous to know whether all kinds of charcoal, like that of wood, might be freed by fire from all the hydrogen combined with them, we found that the charcoal of ſugar,

* No. 142.

wax, and animal matters, after being ſubjected to the action of a ſtrong heat, were perfectly ſimilar to common charcoal, for, like it, they produced no water by combuſtion. Our intention in making theſe experiments not only was to aſcertain whether theſe kinds of charcoal were united with hydrogen, but alſo to determine the relative quantities of oxygen they might contain above that neceſſary to convert them into carbonic acid.

But all thoſe kinds of charcoal above mentioned, as well as coak, plumbago, and anthracite, required nearly the ſame quantity of oxygen. The following is the reſult of the experiments:

The apparatus was the ſame as that employed for the combuſtion of the charcoal of wood. It will, perhaps, not give complete ſatisfaction, on account of the ſuſpicion generally entertained of the permeability of bladders: we ſhall, however, obſerve, that thoſe which we employed were prepared in ſuch a manner as not to ſuffer the gas contained in them to eſcape. Beſides, the reſults which we obtained, and of which we ſhall give an exact account, are ſo agreeable to thoſe of Lavoiſier, and to that given to us by the combuſtion of the charcoal of wood in a balloon filled with oxygen, that they may with certainty be depended on.

Kinds of Charcoal burnt.	Quantities employed.		Carbonic Acid,		Loſs neglected.	A hundred Parts of Carbonic Acid are compoſed of	
	Charcoal	Oxygen.	which ought to have reſulted.	which actually reſulted.		Charcoal	Oxygen.
	Gram.	Gram.	Gram.	Gram.	Gram.		
Charcoal of Sugar	1·63	3·93	5·56	5·46	0·10	29·3	70·7
Of Wax	1·05	2·72	3·77	3·65	0·12	27·8	72·2
Plombago	2·44	6·36	8·80	8·80	0·00	27·8	72·2
Anthracite	2·05	5·16	7·21	7·21	0·00	28·4	71·6
Animal Charcoal	1·55	4·08	5·63	5·68	0·00	26·9	73.1

The combuſtion of plumbago was the moſt intereſting. The whole was not burnt. The portion which remained had become of a pale black colour exactly like charcoal: at ſome parts of its ſurface it appeared that the texture of its parts had become leſs compact, and that the black colour was entirely owing to this attenuation.

Many

Many ſubſtances which have a fine ſplendour become tarniſhed when ſcraped: oxygen, by ſcratching, as we may ſay, the plumbago, produces in it ſmall vacuities which diſperſe the rays of light, and ſuffering them no longer to be reflected towards the eye but in a ſmall quantity: they therefore produce only a weak ſenſation, and the body is judged to be tarniſhed.

Beſides this experiment, in which the black colour generally obſerved in the carbonaceous principle ſeems to us to be owing to its diviſion and its texture, we have had occaſion to ſee the charcoal of turpentine and wax, which are commonly ſo black and dull, become brilliant like plumbago when their parts became more compact.

It is known that Prieſtley, that illuſtrious obſerver, was acquainted with this charcoal of turpentine, and which he poſitively called white charcoal.

Thus charcoal, whatever be its texture or colour, if it has been heated, is always the ſame, contains no hydrogen, and requires for its combuſtion the ſame quantity of oxygen. The alkaline or earthy matters, which may vary the carbonaceous principle without making any change in it, is not conſidered.

Theſe experiments, indeed, do not prove that the diamond does not make an exception; but they give us reaſon to wiſh for a new combuſtion of that body, which is too dear to be ſubjected to this proceſs on a large ſcale.

[To be continued.]

XVI. *Notices reſpecting New Books.*

Philoſophical Tranſactions of the Royal Society of London for the Year 1802. Part i.

THE preſent part, which is extremely intereſting, contains as follow:—1. The Croonian Lecture. On the Power of the Eye to adjuſt itſelf to different Diſtances when deprived of the Cryſtalline Lens. By Everard Home, Eſq. F.R.S.—2. The Bakerian Lecture. On the Theory of Light and Colours. By Thomas Young, M.D. F.R.S. Profeſſor of Natural Philoſophy in the Royal Inſtitution.—3. An Analyſis of a mineral Subſtance from North America, containing a Metal hitherto unknown. By Charles Hatchett, Eſq. F.R.S.—4. A Deſcription of the Anatomy of the *Ornithorynchus paradoxus*. By Everard Home, Eſq. F.R.S.—5. On the Independence of the analytical and geometrical Methods of Inveſtigation; and on the Advantages to be derived

rived from their Separation. By Robert Woodhouſe, A.M. Fellow of Caius College, Cambridge.—6. Obſervations and Experiments upon oxygenized and hyperoxygenized Muriatic Acid; and upon ſome Combinations of the Muriatic Acid in its three States. By Richard Chenevix, Eſq. F.R.S. and M.R.I.A.—7. Experiments and Obſervations on certain Stony and Metalline Subſtances which at different Times are ſaid to have fallen on the Earth; alſo on various Kinds of Native Iron. By Edward Howard, Eſq. F.R.S.—Appendix.—Meteorological Journal kept at the Apartments of the Royal Society by Order of the Preſident and Council.

Tranſactions of the Linnean Society, Vol. vi. London 1802.

THIS reſpectable Society, to whom the public have been already indebted for many valuable papers on different objects of natural hiſtory, continue their labours with unabated zeal. The preſent volume, which is illuſtrated with thirty-one plates, ſeveral of them elegantly coloured, contains the following articles:—1. A Diſſertation on two Natural Genera hitherto confounded under the Name of Mantis. By Anthony Auguſtus Henry Lichtenſtein, D.D. F.M.L.S. Tranſlated from the German by Thomas Young, M.D. F.R.S. and L.S.—The Botanical Hiſtory of the Genus Ehrharta. By Olof Swartz, M.D. F.M.L.S.—3. Account of a Microſcopical Inveſtigation of ſeveral Species of Pollen, with Remarks and Queſtions on the Structure and Uſe of that Part of Vegetables. By Luke Howard, Eſq. of Plaiſtow, in Eſſex.—4. Obſervations on Aphides, chiefly intended to ſhow that they are the principal Cauſe of Blights in Plants, and the ſole Cauſe of the Honey-dew. By the late Mr. William Curtis, F.L.S.—5. Remarks on the Genera of Pæderota, Wulfenia, and Hemimeris. By James Edward Smith, M.D. F.R.S. P.L.S.—6. An Illuſtration of the Genus Solandra. By Richard Anthony Saliſbury, Eſq. F.R.S. and L.S.—7. Obſervations on ſome remarkable Strata of Flint in a Chalk-pit in the Iſle of Wight, in a Letter from Sir Henry Charles Englefield, Bart. F.R.S., to John Latham, M.D. F.R.S. and L.S.—8. Remarks on ſome Britiſh Species of Salix. By James Edward Smith, M.D. F.R.S. P.L.S.—9. Deſcriptions of four new Species of Fucus. By Dawſon Turner, M.A. F.L.S.—10. Deſcription of Callicocca Ipecacuanha. By Felix Avellar Brotero, Profeſſor of Botany in the Univerſity of Coimbra, F.M.L.S.—11. Obſervations on the Curculio Trifolii, or Clover Weevil, a ſmall Inſect which infeſts the Heads of the cultivated Clover, and deſtroys the Seed. In a Letter to Thomas Marſham, Eſq. Tr. L.S., by William

Markwick, Eſq. F.L.S. With additional Remarks by Mr. Marſham.—12. Further Obſervations on the Curculio Trifolii. In a Letter to William Markwick, Eſq. F.L.S. by Martin Chriſtian Gottlieb Lehmann, M.A. of Göttingen.—13. Deſcription of Brotera perſica and Muſtelia eupatoria, two new Plants cultivated in the Botanic Garden of Halle, by Curt Sprengel, M.D. Profeſſor of Botany in the Univerſity of Halle.—14. Obſervations on the Hinges of Britiſh Bivalve Shells. By Mr. William Wood, F.L.S.—15. Catalogue of the more rare Plants found in the Environs of Dover, with occaſional Remarks. By Mr. Lewis Weſton Dillwyn, F.L.S.—16. Deſcriptions of ſome ſingular Coleopterous Inſects. By Charles Schreibers, M.D. Deputy Profeſſor of Natural Hiſtory in the Univerſity of Vienna.—17. Deſcription of Menura ſuperba, a Bird of New South Wales. By Major-General Thomas Davies, F.R.S. and L.S.—18. On the Doryanthes, a new Genus of Plants from New Holland, next a-kin to the Agave. By Joſeph Correa de Serra, LL.D. F.R.S. and L.S.—19. Obſervations on ſeveral Species of the Genus Apis, known by the Name of Humble-bees, and called Bombinatrices by Linnæus. By Mr. P. Huber, of Lauſanne, in Swiſſerland.—20. Botanical Characters of four New-Holland Plants, of the Natural Order of Myrti. By James Edward Smith, M.D. F.R.S. P.L.S.—21. Additional Obſervations on ſome remarkable Strata of Flint in the Iſle of Wight. In a Letter from Sir Henry Charles Engleſield, Bart. F.R.S., to John Latham, M.D. F.R.S. and L.S. of Romſey.—22. Deſcription of a new Species of Viola. By Thomas Furly Forſter, Eſq. F.L.S.—23. Deſcription of the Fruit of Cycas revoluta. By James Edward Smith, M.D. F.R.S. P.L.S.—24. Species of Erica. By Richard Anthony Salisbury, Eſq. F.R.S. and L.S.

Remarks upon Chemical Nomenclature, according to the Principles of the French Neologiſts. By RICHARD CHENEVIX, *Eſq. F.R.S. M.R.I.A., &c.* 12*mo.*

THIS little work, which every one who ſtudies chemiſtry ought to be poſſeſſed of, contains:—1. An Introduction.—2. General Obſervations and Rules.—3. Faults which are the moſt commonly found in the Periodical Publications, and proceeding chiefly from Inattention, but partly from Miſapplication of the Rules.—4. Obſervations upon ſuch Terms in our Language as do not ſeem to be the moſt appoſite to render the French Expreſſion.—5. Obſervations upon certain Denominations which in the Original are not conformable to the Principles of the Syſtem.—6. Obſervations

tions upon ſuch Parts of the Syſtematic Nomenclature as appear to have been left defective by its Authors.—7. Remarks upon an Eſſay on Chemical Nomenclature by Dr. Dickſon.—8. Remarks upon a Paper on Chemical and Mineralogical Nomenclature, by Mr. Kirwan.—9. Obſervations on ſome Parts of Chemical Language which do not properly come under the Head of Nomenclature.—10. On the Syſtem of Chemical Signs.—11. Obſervations on the Syſtem of Chemical Nomenclature propoſed by Brugnatelli.

Afhandling rörande Mechaniquen med Tillämpning i Synnerhet til Bruk ach Bergwerk, &c. A Treatiſe of Mechanics, with the Application of them to Mining and Iron-works in particular. By SVENO RINMANN, Knight of the Order of Vaſa, &c. Vol. ii. 4to. Stockholm 1798.

Afhandling rörande Mechaniquen med Tillämpning i Synnerhet til Bruk ach Bergwerk, &c. A Treatiſe on Mechanics, with the Application of them to Mining and Iron-works in particular. By ERIK NORDWALL, &c. vol. i. 4to. Stockholm 1800.

THE ſociety of the proprietors of mines and iron-works in Sweden gave ſuch liberal encouragement and ſupport to Mr. Rinmann, who has been of ſo much ſervice to mining in Sweden, that he was enabled in the year 1772 to publiſh an Introduction to the Art of Improving the Manufactory of Iron and Steel; in 1782, his Hiſtory of Iron, ſince tranſlated into German; and, in 1789, his large Dictionary of Mining, in quarto. The ſociety ſo early as 1784 had engaged him to undertake, with the aſſiſtance of Mr. Nordwall, a ſyſtem of mechanics applicable to the working of mines, or a theoretical and practical treatiſe on all the apparatus and water-works, a knowledge of which is neceſſary to iron-maſters and thoſe who ſuperintend iron manufactories. Mr. Rinmann undertook the practical part of this work which we have here announced, and which comprehends the following chapters:—1ſt, On the general conſtruction of dams or dykes, of their height and breadth, with a deſcription of more than twelve different kinds, and the method of conſtructing them: 2d, Of canals and ciſterns: 3d, On the conſtruction of water-wheels, and particularly thoſe uſed for working hammers: 4th, Of the manufacturing bar iron: 5th, Of hammers and other apparatus for blackſmiths: 6th, Of the tilting hammer, where weight is not ſo much conſidered as the greater frequency of the ſtroke: 7th, Of rolling and ſplitting iron: 8th, Of wire-drawing: 9th, Of machines

for

for boring cannon to work both horizontally and vertically, the whole apparatus belonging to them, and the method of improving them. The detailed descriptions which the author gives of all these machines, constructed under his own inspection, are illustrated by accurate engravings, to each of which a proper scale is added. Most of the plates were engraved from drawings executed under his own eye, or by his sons. The invention, delineation, and construction of a steel hammer of cut granite, belongs, however, exclusively to his younger son, who was appointed by the College of Mines to supply his father's place during his long illness. The drawings respecting dams and dykes are by Mr. Nordwall, who has invented a new and advantageous method of constructing canals of cut granite for hammer-works.

The theoretic part, announced also as above, is the work of Mr. Nordwall, and was not published till 1800. The experiments made on a small scale, in regard to the motion and power of water, are not sufficient for establishing a general theory, as it is not yet known with certainty what results would be given by experiments on a large scale. For establishing the theory of the action of water on water-wheels, a peculiar machine was invented by the late Polhem, the object of which was to determine the power of water according to the different heights from which it falls, the best method of constructing float-boards, and to determine according to the different depths the size of the troughs. Some experiments made on this subject by the late Wallerius may be found in Triewald's Lectures on Natural Philosophy, in Elvius's Treatise on the Action of the impelling Power of Water, and here and there in the papers of the Academy of Sciences at Stockholm. In the years 1752 and 1753 the late ingenious Mr. Smeaton made similar experiments, which were published in 1794 under the following title: Experimental Inquiry concerning the natural Powers of Wind and Water to turn Mills and other Machines. Some newer experiments have been given by the abbé Bossut in his excellent work on Hydrodynamics. By all these, however, the subject has not been illustrated so fully as its importance and extent required. It has been found, indeed, by experiment, that the moving momentum of the power of water is very different according to the nature of the wheels driven by it, the more or less oblique situation of the troughs, the different position of the float-boards, and their distance from each other; but it has never yet been sufficiently examined what variations may be produced by the different pressure of the water in the trough; the different forms and construction of the float-boards in

overshot,

overſhot, half-overſhot, and underſhot wheels; by the different depths, curvature, and breadth of the troughs; the different breadth of the float-boards in regard to the diameter of the wheel; the height and thickneſs of the column of water by which it is impelled; the greater or leſs velocity with which the wheel revolves; its height as compared with that from which the water falls upon it; the effect which the water produces by its weight or its impulſe alone on the wheel, &c. All theſe points muſt be explained in a theoretical treatiſe to render it ſufficiently uſeful, and before this can be done it will be neceſſary to make a great many reſearches, not merely founded on mathematical principles and demonſtrations, which may often miſlead the practical mechanician, but on inconteſtable experiments; and even if this ſhould be fully accompliſhed, it would ſtill be neceſſary to examine what ratio the reſults ariſing from experiments on a ſmall ſcale bear to thoſe made on a large ſcale. This ratio the author has here endeavoured to determine with as much accuracy as poſſible. In regard to the ſmall difference which is ſometimes obſerved in experiments with ſmall overſhot wheels, on account of the attraction of the water by the float-boards, and in conſequence of which the action is ſomewhat greater on a large ſcale, the author, in order to obtain a certain formula, made various experiments on a large ſcale, and compared them with thoſe of Polhem, Smeaton, and Boſſut, and his formulæ with thoſe of Karſten, Käſtner, Deſaguliers, Belidor, Fabre, Elvius, &c.

The whole work conſiſts of three parts.—I. *Mechanics.* The author here treats of the weight of bodies, and gives a table of the weight of an ell of the different kinds of bar iron, the weight of a cubic foot of water being $62\frac{1}{2}$ pounds: of the different powers, and their action; accelerated motion, and the motion of falling bodies; the equilibrium of powers that counteract each other: of compound motion; the reſolution and compoſition of powers; the motion of bodies on an inclined plane: of the motion of the pendulum; the centre of percuſſion or point of oſcillation; the circular motion of a body, and particularly the fly-wheel; of the centre of gravity, the lever, the pulley, the axle and wheel, the inclined plane, the wedge, friction, the ſtiffneſs of ropes; of the power of bodies in a ſtate of motion; on the motion of bodies which impinge directly againſt each other; on the impinging of hard and elaſtic bodies; of the motion of hard and elaſtic bodies, which impinge on each other obliquely; and on eſtimating the power of bodies which put machines in motion.—II. *Hydroſtatics.* This part treats on the preſſure of

of fluids; on their equilibrium with ſolid bodies immerſed in them, with a table of the ſpecific gravities of ſome fluids and ſolids; on the utility of being acquainted with the ſpecific gravity of bodies; on the equilibrium of elaſtic bodies, and particularly the air; on pumps; on conveying water and levelling.—III. *Hydraulics.* The contents of this part are: on the motion of water in general, when it flows from apertures in the veſſel which contains it; of the velocity of its efflux; on the quantity of water which iſſues when the velocities are equal; on the quantity of the water which iſſues through lateral apertures when the velocity is not uniform; on the quantity of water which iſſues from pipes; on the motion of water in dams and canals; on the different methods of determining the velocity of running water; on the motion of water in ſtreams; on the impinging force of water; on the fall of water; on the different method of applying float-boards to wheels, and the action of the moving power of the water thence depending; on the proper form of troughs for overſhot, half overſhot, and underſhot wheels; on the proper diameter of the wheels; on the greateſt poſſible action of the moving power of water on the different kinds of wheels; on the action of the compound moving force of water, and on the effect of the moving power of water on horizontal wheels. —This work ſhows that the author is not a mere theoriſt, and that he has united the principles of ſound theory with very extenſive practice.

Hiſtoire des Mathematiques, dans laquelle on rend Compte de leur Progrès depuis leur Origine juſqu'à nos Jours, &c. A Hiſtory of the Mathematics, containing an Account of their Progreſs from their Origin to the preſent Time; in which a View is given of the principal Diſcoveries in every Branch of the Mathematical Sciences, of the Diſputes which have ariſen among the Mathematicians, and of the principal Circumſtances in the Lives of the moſt celebrated. A new Edition, conſiderably augmented, and continued to the preſent Period. By J. E. MONTUCLA, of the National Inſtitute. Vols. iii. and iv. 4to. completed and publiſhed by Jerome Delalande, of the National Inſtitute, with nineteen Plates, and the Portraits of Montucla and Delalande.

MONTUCLA, above thirty years ago, publiſhed the two firſt volumes of this work, which contain the hiſtory of the mathematics to the end of the ſeventeenth century. This part was incomplete; and the author made conſiderable additions

ditions to theſe two volumes, which were republiſhed about two years ago.

The third and fourth volumes, now publiſhed, contain the hiſtory of the mathematics ſince the commencement of the eighteenth century to the preſent period. This century is more fertile than any of the preceding, having produced a great many men of eminence in the mathematical ſciences; as Euler, Maclaurin, the two Simpſons, Dalembert, Condorcet, La Grange, Landen, De la Place, Delalande, &c. Montucla died while employed in putting the laſt hand to this part, by which means the end of the third volume, and great part of the fourth, were left imperfect. Delalande undertook to ſupply the deficiency, as a teſtimony of reſpect to the memory of his friend; and the reſult of his labour is now preſented to the public. Delalande has prefixed to the third volume a preface, and added to the fourth a life of Montucla; with an index to the two laſt volumes, like that given by Montucla with the firſt and ſecond.

XVII. *Proceedings of Learned Societies.*

ROYAL INSTITUTION OF GREAT BRITAIN.

AT a meeting of the managers and viſitors of the Royal Inſtitution of Great Britain, held at the houſe of the Inſtitution, on the 26th day of April 1802, the following report, relative to the preſent ſtate of the Inſtitution, was laid before them by Count Rumford.

On the 25th of May laſt year I had the honour to lay before the managers an account, which by their directions was publiſhed in the journals of the Inſtitution on the 13th of June, reſpecting the progreſs that had been made in the arrangement of the Inſtitution at that time, and of the works that were then going on at the houſe of the Inſtitution; and I ſhall now briefly ſtate to the managers and viſitors what has ſince been accompliſhed, and what ſtill remains to be done to complete this great and intereſting eſtabliſhment in all its details.

The new lecture-room has been finiſhed, and is acknowledged to be one of the moſt beautiful and moſt convenient ſcientific theatres in Europe. It is ſo favourable to the propagation of ſound, that though it is ſufficiently capacious to contain 900 perſons, a whiſper may be diſtinctly heard from one extremity of it to the other, and no echo is ever perceived in it on any occaſion. It is ſo contrived, that day-light may be

be entirely excluded in a moment, by lowering the moveable ceiling of the lantern, by which the light enters the room from above, and allowing it to reſt on the cornice which makes the finiſh of the lower part of the lantern, juſt above the level of the flat part of the ceiling of the room.

The form of the room is ſemicircular, with an addition of a parallelogram, equal in length to the diameter of the circular part of the room (60 feet), and 15 feet wide; and there are eleven rows of ſeats riſing one above the other below, and three rows of ſeats in the gallery: and there is a covered circular paſſage, eight feet wide, all round the room, without, under the higher rows of ſeats, next the wall, and four convenient openings or *vomitoria*, with light doors with two wings, which ſhut of themſelves without noiſe, forming ſo many paſſages of communication between the lower part of the theatre or pit, and the arched gallery or paſſage without.

The floor and ſeats of this theatre are painted of a dark green colour; and the ſeats are all covered with green moreen cuſhions. The floor of the circular paſſage without, which ſurrounds the pit, and the ſtairs belonging to the *vomitoria*, are all covered with green cloth to prevent the noiſe of the footſteps from being heard of thoſe who come in or go out of the theatre during the lecture.

The windows which form the lantern (which is 15 feet in diameter) are all double, which not only renders the temperature of the room very equal and pleaſant, but alſo prevents ſo effectually all noiſes from without diſturbing the ſilence which reigns in the room, that even the rumbling of the carriages which paſs in the neighbouring ſtreets is never heard in it.

This theatre is warmed in cold weather by ſteam, which coming in covered and concealed tubes, from the lower part of the houſe, circulates in a large ſemicircular copper tube, eight inches in diameter, and above 60 feet long, which is concealed under the riſing ſeats of the pit.

Adjoining to this new theatre is the apparatus room, which communicates with it by a door which is on one ſide of the large open chimney fireplace within the theatre, and juſt behind the lecturer's table, which chimney fireplace ſerves for placing the furnaces that are occaſionally uſed in the chemical experiments.

The repoſitory, which is 44 feet long, and 33 feet wide, (the ceiling of which, and the floor of the theatre, which is above it, being ſupported by two rows of handſome columns,) is finiſhed, and already contains a conſiderable number of ſpecimens of new and uſeful mechanical contrivances.

The chemical laboratory, in which there is proviſion made for placing and uſing no leſs than ſixteen furnaces of different kinds at the ſame time, is quite finiſhed, and has been furniſhed, under the direction of the committee of chemiſtry (which has been formed ſince the laſt year), with a very complete chemical apparatus, and alſo with a conſiderable proviſion of materials neceſſary in making chemical experiments.

All the workſhops of the Inſtitution are now quite finiſhed; and they have been furniſhed with the moſt complete ſets of tools that could be procured; and ſeveral excellent workmen are now employed in them; and a great variety of uſeful articles, deſigned as models for imitation, have already been manufactured in the houſe, and are ready to be delivered to any of the proprietors or ſubſcribers to the Inſtitution who may be diſpoſed to purchaſe them.

The great kitchen at the houſe of the Inſtitution has been finiſhed, and now contains a variety of new and uſeful utenſils, and implements of cookery, many of which are in daily uſe, and others which are not are ſo expoſed to view as to be eaſily underſtood, and their merit appreciated.

The dining-room and the managers room, which is adjoining to it, have both been quite finiſhed and furniſhed.

The converſation-room has been finiſhed, and every thing has been prepared for its being uſed as a coffee-room. It is now ſet apart for the reading of the domeſtic newſpapers, of which no leſs a number than ten are regularly taken in; and it has been furniſhed with a ſet of the beſt geographical maps and charts that were to be procured. In ſelecting them, the advice and aſſiſtance of that able geographer major Rennell, were obtained. The maps are fitted up according to a new method, which has been found to be very convenient, and at the ſame time to contribute much to the economy of ſpace, and to the preſervation of the maps.

The firſt reading-room (that neareſt to the great hall) has lately been appropriated excluſively to the reading of foreign newſpapers. It is lighted up, as formerly, every evening; and on the table are found ſeven foreign gazettes, from different parts of the continent, in the French and German languages, which are regularly taken in, and which, coming by the poſt, conſtantly arrive at the earlieſt periods.

Mr. Stanhope, of the general poſt-office, has generouſly undertaken to manage the whole buſineſs of procuring theſe foreign newſpapers, and to cauſe them to be delivered at the houſe of the Inſtitution free of all expenſes for poſtage.

The

The ſecond, or principal reading-room, which is 26 feet long, by 24 wide, has been fitted up in a very complete and elegant manner, and furniſhed with neat book-caſes, which now extend round three ſides of the room, affording ſpace for more than 3800 volumes. This arrangement has rendered it poſſible to allow the ſecond lecture-room (which at ſome future period is to become the library) to remain for ſome time longer in its preſent ſtate; and it will no doubt be found very uſeful for giving, occaſionally, lectures on particular ſubjects, unconnected with the general courſes of lectures that are regularly given in the great lecture-room by the profeſſors and lecturers of the Inſtitution. This ſecond lecture-room will likewiſe be found very convenient for the meetings of the committees of the Inſtitution, and for exhibiting new experiments to ſelect meetings of ſcientific men.

But to return to the principal reading-room. The accommodations for thoſe who frequent this room have been greatly augmented ſince the laſt year. There are now two long mahogany tables (each 11 feet in length, and 3 feet 10 inches wide), covered with green cloth, which are placed parallel to each other, on oppoſite ſides of the room; and each of theſe tables is well lighted at night by an elegant Grecian lamp of three branches, ſuſpended by a chain from the ceiling of the room, and covered with a ſhade of white ſilk.

On theſe tables are found no leſs than 54 foreign and domeſtic, ſcientific and literary periodical publications, which are regularly taken in.

The books in the library of the Inſtitution have been conſiderably increaſed during the laſt year, both by preſents and by new purchaſes.

The principal reading-room has been ornamented by an elegant buſt of his majeſty, our moſt gracious ſovereign, patron of the Inſtitution; and by the buſts of thoſe great luminaries of ſcience, Bacon, and the immortal Newton.

With regard to the public opinion reſpecting the Inſtitution, I have the moſt ſenſible ſatisfaction in being able to lay before the managers and viſitors indiſputable proofs of its growing reputation. The reading-rooms and lectures at the houſe of the Inſtitution are conſiderably more frequented this year than they ever have been before; and, although the prices of proprietors' ſhares, and of life and annual ſubſcriptions, have been conſiderably raiſed, the liſts of proprietors and ſubſcribers have, during the laſt ten months, been augmented by no leſs than 154 new names, as will appear by the following ſtatement.

There were belonging to the Royal Inſtitution

	On the 5th June, 1801.	On the 26th April, 1802.	Augmentation.
Proprietors - - -	325	341	16
Life ſubſcribers - -	268	284	16
Annual ſubſcribers -	527	649	122
Total	1120	1274	154

The income and pecuniary reſources of the Inſtitution have, of courſe, kept pace with the increaſe of its proprietors and ſubſcribers; and its expenſes, though they have neceſſarily been very heavy, while ſo great and extenſive a plan has been carrying into execution, yet they have been regulated with ſo much order and economy, that the proprietors will, no doubt, be ſatisfied with the accounts that will be laid before them at their next annual meeting, which will be held in a few days.

It will ſtill be freſh in the recollection of the managers and viſitors, that, when, in the year 1800, it was finally determined by the proprietors to undertake the additional buildings at the houſe of the Inſtitution, it was then thought to be quite impoſſible to complete ſo great and expenſive an undertaking without a loan of at leaſt 5000l.; and it will likewiſe be remembered that, on opening a ſubſcription for that purpoſe, no leſs a ſum than 7000l. was generouſly offered, by a comparatively ſmall number of the proprietors, in a very ſhort time. It will alſo be recollected that I took the liberty in the report which I had the honour to lay before the managers laſt year, on the 25th of May, to expreſs a hope that not only the expenſes of the new buildings above-mentioned, but of others alſo which were wanted, and of all the alterations and additions that would be neceſſary to be made to finiſh the houſe in the moſt complete manner, and to furniſh it elegantly, might, perhaps, with due care and attention, be defrayed without calling for any part of that ſum of 7000l., which had been ſubſcribed to enable the managers to complete this great undertaking.

I have now, in common with my two colleagues of the committee of expenditure (Lord Pelham and Mr. Sulivan), who with myſelf have been ſpecially charged by the managers of the Inſtitution with the ſuperintendance and control of theſe expenſes, the pleaſure to ſtate that theſe hopes have not been diſappointed.

By

By the accounts which have been laid before the viſitors it appears,

That the whole of the ſums that have from time to time become due to Mr. Hancock, who contracted with the managers for completing the new buildings, have been regularly paid. That his work having been finiſhed, and regularly examined by the ſurveyor of the Inſtitution, his accounts have been cloſed, and the balance due to him from the Inſtitution has been ſettled.

That the inſtalments agreed to be advanced to him, on his ſeparate contract for completing the attic ſtory, have likewiſe been regularly paid, and that no more than about 500l. will be due to him, on his laſt contract, when he ſhall have completed the whole of that work; which will be finiſhed in a few weeks.

It appeared likewiſe, by theſe accounts, that all the carpenters, plumbers, painters, and glaziers bills, for extra work at the houſe of the Inſtitution,—not included in Mr. Hancock's contracts,—have been brought to account: that the ſalaries and wages of thoſe who conſtitute the eſtabliſhment of the Inſtitution have been regularly paid; and that all the tradeſmens bills have been duly checked, and regularly diſcharged.

And, laſtly, that all the ſums due from the Inſtitution on current accounts, including every demand that can be brought againſt the Inſtitution, even after all the new works now carrying on at the houſe of the Inſtitution ſhall have been completed, amounts to about 3900l.; while the ſums belonging to the Inſtitution in the hands of their different bankers, added to thoſe ſums which are due to the Inſtitution from proprietors and ſubſcribers, and from ſome other perſons, amounts to about 8100l.

From this ſtatement it is evident that the Inſtitution has been completed without any debt being incurred; and, by an account which has been laid before the managers and viſitors, it appears that the preſent annual income of the Inſtitution is quite ſufficient to defray all the expenſes of keeping it. The Royal Inſtitution of Great Britain may therefore be conſidered as finiſhed and firmly eſtabliſhed. That it may long continue to flouriſh is, no doubt, the ardent wiſh of thoſe who are connected with it; and alſo of all thoſe who are acquainted with the principles on which it is founded, and who know how powerfully it muſt contribute to the general diffuſion of an active ſpirit of inquiry and uſeful improvement among all ranks of ſociety.

LINNEAN SOCIETY OF LONDON.

On Tuesday, the 11th of May, this society held their first meeting under a royal charter of incorporation, wherein the following first fifteen fellows are appointed to form the council for the year ensuing, viz.

George earl of Dartmouth, F. R. S.
James Edward Smith, M. D. F. R. S. president.
Thomas Marsham, esq. treasurer.
Alexander M'Leay, esq. secretary.
Jonas Dryander, esq.
The Rev. Samuel Goodenough, LL. D.
A. B. Lambert, esq. F. R. S.
R. A. Salisbury, esq. F. R. S.
W. G. Maton, M. D. F. R. S.
William Lewis, esq.
Thomas Furley Forster, esq.
Charles Hatchett, esq. F. R. S.
The Rev. Thomas Rackett, M. A.
John Symmons, esq. F. R. S.
Thomas Young, M. D. F. R. S.

LITERARY AND PHILOSOPHICAL SOCIETY, NEWCASTLE.

This society, instituted only a few years ago, is now in so flourishing a state, that it has at this time under consideration a plan for establishing a lectureship on the subject of natural and experimental philosophy. A paper on the subject, drawn up by Mr. Thomas Biggs, one of the members, has been printed and circulated by the society; and such exertions are making, that we hope soon to be able to announce that a sufficient fund has been obtained for carrying this desirable measure into effect.

PHYSIOLECTICAL SOCIETY.

A society under the above title has just been instituted at Birmingham "for the purpose of improving its members in natural philosophy by lecture, experiment, and discussion." A suitable apparatus is to be provided at the expense of the members, each of whom during the sessions is to lecture, in his turn, upon a subject in natural philosophy chosen by himself, but approved by a quorum of the society, and visiting auditors are to be admitted to the sittings under certain regulations. This is as it ought to be, and does much credit to those scientific gentlemen who planned and have united for such objects. This will not only insure their own improvement,

provement, but tend to ſpread a taſte for philoſophical ſtudies, which cannot fail to prove eventually highly beneficial even in a commercial point of view, as leading to ſcientific improvements in the various manufactures of the neighbourhood. We wiſh ſimilar inſtitutions were more general.

ROYAL ACADEMY OF INSCRIPTIONS, FINE ARTS, HISTORY, AND ANTIQUITIES, AT STOCKHOLM.

As the ſociety received no anſwer to the following queſtion: A hiſtorico-critical treatiſe on the printed and manuſcript works written by individuals of the royal family; it has been again propoſed for the year 1802.

The following prize queſtions have alſo been propoſed:

Foreign languages.—An examination of the advantages or diſadvantages of the new methods invented in modern times for facilitating the ſtudy of the ſciences; and whether theſe methods are prejudicial to real learning. The prize is a gold medal of the value of twenty-ſix ducats.

Antiquities.—An eſſay on the origin of the arts and manufactures in Sweden, and on the progreſs of them, to the acceſſion of Guſtavus I.; with a general view of the laws and regulations which relate to trades and companies. The prize is a gold medal of fifteen ducats.

Inſcriptions and Devices.—Sketch of epitaphs for king Charles VIII.; Knutſon, Birger Jarl, and Terkel Knutſon, regents of the kingdom during the minority of king Birger. Sketch of medals on the moſt remarkable events which took place in Sweden in the courſe of the 18th century, to be choſen at the pleaſure of the author. The prize is a gold medal of twelve ducats.

The papers muſt be tranſmitted to the academy, in the uſual manner, before the 20th of January 1803.

ACADEMY OF SCIENCES AT BERLIN.

On the 28th of January 1802 the academy held a public ſitting, which was opened by M. Merian with a diſcourſe in French; after which he read the eulogy of M. Selle, the late director of the philoſophic claſs. He announced alſo that his intimate friend M. Gerhard had diſcovered that, in galvanic experiments, nickel combined with zinc produces the ſame effect as ſilver and copper.

Profeſſor Bode read a hiſtory of the diſcovery of the new planet Ceres, obſerved by him on the 15th, 23d, 25th, and 26th of January.

Klaproth, in a memoir on galvaniſm, gave ſome details on the laſt experiments made on a large ſcale on that ſubject by

Van Marum, of Haarlem, comparing them with analogous experiments made with the Tylerian electric apparatus.

The ſame chemiſt made ſome experiments with the Voltaic pile conſtructed, according to the directions of Van Marum, with 52 plates of zinc and copper, each five inches ſquare, in two diviſions: the principal phænomenon obſerved was the combuſtion of metals.

PHILOMATIC SOCIETY.

C. Pictet read a notice on the ſtate of agriculture in the environs of Alicant. The ſoil in the neighbourhood of Alicant is in general light; on the heights it is formed almoſt entirely of the wrecks of rocky and calcareous mountains, while in the valleys it is ſandy, with beds of clay and marl: but in a climate ſo warm, this difference in the nature of the ſoil is of leſs importance to agriculture than that which reſults from the dryneſs or moiſtneſs of the ground. C. Pictet deſcribes ſeparately the agriculture of the dry lands and that of thoſe which are watered.

The tree reſerved almoſt excluſively for the dry land is the almond-tree, with a hard or ſoft ſhell: it flowers in the month of February. The green bark of the almonds is employed in the manufacturing of ſoap, on account of the alkali which it contains.

The caroub-tree, the fruit of which ſerves as food to the mules, is alſo cultivated, and that variety of the olive-tree which produces ſmall black olives: the oil of them is of a bad quality, becauſe the olives are left heaped upon each other for a long time before the oil is made.

The date-tree at Alicant riſes to the height of 60 feet; the fruit is inferior in quality to that of Barbary. The leaves of this tree are employed for a very ſingular purpoſe: they are blanched, and being then bleſſed by the prieſts, are ſold to individuals, who place them in the balconies of their houſes as preſervatives from all kinds of danger. Theſe blanched leaves are exported alſo to Italy. The leaves of the male or barren date are employed for this purpoſe. A perſon climbs up to the top of the tree, turns up the exterior leaves which have ſhot forth, and they are ſurrounded by a cord which is gradually drawn tighter, after which they are covered with a bundle of ſtraw to ſecure them from the light. The bundle of ſtraw is not entirely cloſed over them till the month of Auguſt. This operation may be repeated every three years on the ſame tree.

The land is cultivated in the neighbourhood of Alicant by two mules yoked to a plough. After the land is ploughed,

the farmers endeavour to level the ground, that it may be watered in a more uniform manner. For this operation they employ a box open before, and having a concave bottom; it is drawn by a mule: the driver holds it behind by means of a handle, and, making it enter the ground when the latter is too high, tranſports what it has pared off to ſome other place where the ſoil is too low.

The uſual rotation for dry land is as follows:—The land is ſuffered to reſt for a year, after which it is ploughed and dunged: it is then ſown with the ſoda plant, then with wheat, and, in the laſt place, with barley.

The ſoda is extracted from a great number of maritime plants; but the two excluſively cultivated at Alicant for that purpoſe are the *Parilla* (*Salſola ſativa*, Linn.), and the *Soſſa* (*Salſola ſoda*, Linn.). The method of cultivating them is the ſame; but the former requires a better ſoil, and produces much better ſoda.

After the land has been ploughed ſeveral times, and dunged, it is ſown with barilla in the month of December: it is ſcarcely covered with earth, and the days when the weather ſeems moſt diſpoſed for rain are choſen for that operation. About the end of winter the field is weeded as often as is neceſſary to deſtroy the weeds. The barilla is ready to be collected in September: that intended for ſeed is left in the ground for a month longer. The plant is eaſily torn up, becauſe it has very ſmall roots: when pulled it is depoſited in heaps, and left for a month to dry. About the middle of October it is burnt. Spherical holes capable of containing about thirty hundred weight of ſoda are made in the earth, above each cavity are placed two bars of iron which ſupport the plants to be burnt, and which are mixed with reeds or ſtraw. Care is taken to make choice of a day when the wind is not too ſtrong, otherwiſe the ſoda would burn too rapidly, and be reduced with more difficulty to a ſolid maſs: it is neceſſary alſo that the air ſhould not be entirely calm; for in that caſe the ſmoke, by not being carried off, dirties the ſoda. The barilla in burning experiences a kind of fuſion, and is reduced to a red maſs, which reſembles a fuſed metal, and which is ſtirred once or twice, in order that the fuſion ſhould be more complete. When the pits are full, which generally requires a whole night, the matter is covered with earth, and it is ſuffered to cool for ten or twelve days: the cake formed is then uncovered, and it is broken into large fragments with hammers; after which it is carried to warehouſes. While the barilla is burning, the ſweepings left the preceding year are thrown into the pits in order that they

they may be fuſed with the reſt. The *ſoſſa* and *barilla* are cultivated not only on the coaſt, but at the diſtance of nearly forty leagues. The ſoda, however, is of an inferior quality with that of Alicant.

The cultivation of wheat and barley preſents nothing remarkable except the defective method of threſhing them. The grain is ſpread out on a plat of ground well covered with graſs, and mules yoked two and two are made to trot over it. Theſe mules are often yoked alſo to an inſtrument called *trillo*, on which the driver places himſelf: this *trillo* is compoſed of two planks joined by two croſs pieces, and turned up before. This operation detaches the grain and breaks the ſtraw. When a gentle wind blows, advantage is taken of it to ſeparate them; they are thrown into the air wih a ſhovel; the ſtraw is carried to a diſtance, and nothing remains but the grain mixed with earth, which is afterwards ſeparated by means of a ſieve.

The environs of Alicant are watered either by wells, from which the water is drawn up by a wheel that moves a rope furniſhed with buckets, or by running water brought entirely from a large reſervoir called *Pantano di Tili*. This reſervoir, begun by the Moors and finiſhed by the Spaniards, is a defile between the mountains, ſhut by a ſtrong wall. The water is ſold to individuals: each proprietor generally receives ſome of it twice every year to water his land, and every fortnight to water his garden.

It is in the diſtricts thus watered that lucern is cultivated; it produces thirteen or fourteen crops annually: but the moſt important production cultivated in the watered diſtricts is the vine.

The vineyards are divided into ſquares with elevated edges that they may be watered with more effect. The vines are pruned in the month of January: they are not ſtripped of their leaves, nor are they ever raiſed up, and they are dunged only when the whole vineyard is renewed: they are dug once in winter and once in ſummer. The vines are watered once or twice every year, and more copiouſly when young. When the grapes are very ripe, they are cut, and ſpread out in a dry place on hurdles made of reeds. When they have loſt their humidity they are preſſed above large ſtone jars, covered with boards which join badly. The grapes are mixed with a little lime, the probable effect of which, according to C. Pictet, is to neutralize the acid, and fix or ſeven men, almoſt naked, preſs them down with their feet. The ſtalks are then ſeparated, and the huſks are thrown into the jars to colour the wine. At the end of eight or ten days the liquor is drawn off and put into caſks.

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The wine made at Alicant is divided into ſeveral kinds: 1ſt, *Moſcatel* or *Malmſy*, which is white and ſweet: 2d, *Aloque*, which is red, &c. and employed in the country for common uſe: 3d, *Fendèllon*, which is that ſweet wine known in foreign countries under the name of *Alicant wine*.

SOCIETY OF EMULATION AT ROUEN.

This ſociety has propoſed the following queſtion:—To indicate for dyeing ſpun cotton of a red colour ſimilar to that called Indian red, a proceſs which ſhall require only ſix deficcations.

The dyed ſpecimens will be ſubjected to the ſame proofs as thoſe dyed in the beſt dye-houſes of Rouen; like them they muſt withſtand the action of ſoap and that of the nitric acid.

The prize will be a gold medal of the value of 600 francs (25l. ſterling), and will be adjudged in the public ſitting of Thermidor 7, year 11 (July 26, 1803).

The memoirs, written in French or in Latin, muſt be tranſmitted, poſt paid, to C. Auber, ſecretary for correſpondence, at the Central School, before the 25th of Meſſidor, year 11 (July 14, 1803).

XVIII. *Intelligence and Miſcellaneous Articles.*

ASTRONOMY.

THE planet diſcovered by Mr. Olbers, of Bremen, on the 28th of March has been calculated by C. Burckhardt, who, after long and laborious operations, has found the elements of this planet in the following manner:—Aſcending node, 172° 28′ 57″; perihelion, 122° 3′ 2″; mean longitude March 31ſt, 162° 51′ 14·2″; inclination, 34° 50′ 40″; mean diſtance from the ſun or greater ſemi-axis, 2·791; eccentricity, 0·2463; diurnal ſidereal motion, 12′ 40·84″: ſidereal revolution, 1703 days 7-tenths. C. Burckhardt has been obliged to calculate the perturbations which this planet experiences from the attraction of Jupiter, and which occaſioned very ſenſible differences in the obſerved places: but theſe calculations are very complex, on account of the great inclination and great eccentricity of that planet. LALANDE.

The orbit of the planet of Olbers, calculated by C. Burckhardt, the elements of which we have publiſhed, agrees within a few ſeconds with the obſervation made on the 26th by Meſſier

Meſſier and Mechain, ſo that this new planet may be conſidered as already well known. Its revolution is 1703 days, or 4 years 8 months and 3 days. That of Piazzi's planet is 4 years 7 months and 10 days: but their diſtances are different on account of the difference of their eccentricities. The planet of Olbers varies from 21 to 35, and that of Piazzi from 27 to 28, the diſtance of the ſun from the earth, being ten. When I publiſhed the two laſt volumes of Montucla's Hiſtory of the Mathematics, I was not able to give the elements of the latter planet: this article will therefore ſerve as a ſupplement. LALANDE.

ANTIQUITIES.

A letter from Naples of a late date contains the following information:—In the muſæum of Portici, belonging to the king of Naples, there have been for a long time nearly eighteen hundred manuſcripts on papyrus, which were found among the ruins of Herculaneum. All the attempts hitherto made to take advantage of this valuable diſcovery have procured only a very inſignificant work of Philodemus on Muſic*. The prince of Wales lately requeſted the court of Naples to authorize Mr. Haiter, one of his librarians, to examine the manuſcripts of Herculaneum, in order to diſcover on what ſubjects they treat, and to publiſh ſuch works as appear moſt intereſting.

Mr. Haiter has entered upon this reſearch with a courage and zeal of which no idea can be formed but by thoſe who have witneſſed the almoſt inſurmountable difficulties he has had to ſurmount in unrolling manuſcripts reduced to charcoal, and ſo brittle, that they break and fall into duſt by the effect of the leaſt breath.

Mr. Haiter has been ſo fortunate as to diſcover, a few days ago, a work of Epicurus entitled *Of the Nature of Things*, which was known only from the mention made of it by ſome writers of antiquity, and which appears to have ſerved as the baſis for the poem of Lucretius on the ſame ſubject. A copy is now making of this manuſcript, and when tranſcribed it will be printed.

Mr. Haiter has employed ten perſons to unroll the ſame number of manuſcripts on papyrus; and there is reaſon to expect from this laudable activity diſcoveries of the more importance, as he will not grow weary like father Anthony, formerly charged with the like labour on works of little im-

* There appears to be here a ſmall error. A manuſcript on the Virtues and Vices, *de Virtutibus et Vitiis*, has alſo been unrolled; and, if we are not miſtaken, a third, the name of which we do not recollect.

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portance, as he proposes to collect only those which relate to poetry or history, or which are in some measure interesting in consequence of the celebrity of their authors.

BABYLONIAN INSCRIPTIONS.

Some time ago we gave a short account of Dr. Hager's ingenious Dissertation on the Inscriptions found on some bricks, brought to this country at the expense of the East India Company, from the ruins of a city on the Euphrates supposed to be the site of the antient Babylon. We now learn that M. Lichtenstein, intendant-general of Helmstadt, in the duchy of Brunswick, having studied one of these inscriptions, (the one of which we gave a copy in our eleventh volume,) has succeeded in decyphering the hieroglyphical characters which it exhibited, and that he means to lay before the learned world an explanation of the principles on which his discovery rests. This discovery, if well founded, will be of immense advantage to history, as the characters which distinguish the monuments of Persepolis and the interior of Asia, and which have hitherto baffled every attempt of the learned to decypher them, seem nearly allied to those of Babylon, from which they are probably derived.

GEOGRAPHY, VOYAGES, AND TRAVELS.

According to the last letters from Mr. Humboldt, dated November 26, 1801, he was then on his way to Quito, and in January 1802 intended to proceed to Lima, thence in the month of May to Acapulco and Mexico, from which he proposed taking a passage to the Philippines, and then to return to Europe by the Cape of Good Hope.

The following account is extracted from a letter dated Leghorn, March 22, 1802, addressed to the editor of the *Magazin Encyclopedique*:—"I have found here a large packet of letters from Ceylon, addressed to me by lord Glenbervie. I learn from the letters of M. de I. that he has sent to London a work on that island. Colonel North, the governor of Ceylon, had so good an opinion of it that he took the trouble himself to correct the English translation. It contains information of every kind respecting this famous island. M. de I., having learned the Portuguese and Cinguese, which are the languages of the country, was enabled to acquire information respecting the antient history of the country, and other branches of antiquity entirely new: this part of the work, therefore, has been sent to the society at Calcutta to be inserted in the *Asiatic Researches*. It shows that Ceylon had for a legislator Boudhoo, whose laws are older, perhaps, than those of Brahma in the peninsula of India, and

differ

differ from them in several important points, such as the mortality of the soul, which Boudhoo admits after a multitude of transmigrations; whereas the Brachmans admit the same transmigrations, and conclude with establishing the immortality of the purified soul. The work, then, contains a description of the manners, customs, and government of the island; account of an embassy to Candia, the capital of the kingdom, in the interior of the island, on which occasion M. de I. served as interpreter; a letter to the governor on captain Symes's embassy to Ava; a dissertation on the agriculture, natural history, mineralogy, botany, &c. of the island; with an account of 3000 insects and other animals prepared and dried, and a collection of 500 drawings of plants and animals sent to the East India company. This work contains also different memoirs on the operations of the governor in regard to labours with which M. de I. was charged. That on the cultivation of the cinnamon states, that a wood 15 miles in circumference became a garden in 18 months: it produced 800 bales of cinnamon: at present it produces 3000, which are worth to the East India company 60,000l. sterling. A memoir on the pearl fishery in the gulph of Mannar, where M. de I. superintended the extraction of the pearls last year in the month of March. Two hundred and fifty boats, with divers, were employed in the fishery: these boats bring the oysters every day on shore, where they are suffered to rot for about a week; they are then washed, after which the fish is boiled and exposed to dry. This matter is then winnowed by women, and the pearls are extracted. In the midst of this air, which might be expected to be rendered poisonous by the stench, the people employed find no more inconvenience than if they breathed the purest air. A memoir on the hunting of elephants, which shows, that of 200 of these animals caught during one of these hunting excursions, 160 perish by disagreeable accidents in consequence of the bad method employed: no more than forty remain to be tamed, though, by simpler means, the loss might be reduced to eight or ten. A journey to the southward part of the island to examine the saline marshes it contains, and to discover the best method of improving the production of salt. In consequence of the topographical observations made by M. de I. during the course of this journey he has been appointed surveyor-general of the island; and fifteen surveyors, in five divisions, are now employed in making plans, and in other operations necessary for the construction of a general map, which is to be finished in two years.

EARTH-

EARTHQUAKES.

A French officer of dragoons, now in garriſon at Lodi, in a letter to his father, dated the 9th of May, gives the following account:—"I write in haſte to inform you, that an earthquake has been felt here, but that I have met with no accident. We were ſitting quietly at breakfaſt, when our houſe gave a terrible craſh, that ſhook us on our ſeats. We ran out and flew to the barracks. Every thing was overturned; the cloaks and portmanteaus rolled about, and the dragoons were tumbled down in attempting to deſcend the ſtairs. Some chimneys were thrown down; all the people were at prayers in the ſtreets. The ſhock commenced at forty minutes paſt ten in the morning, and laſted about three ſeconds. We have eſcaped with the fright. We might now laugh were we not much affected, when we learned that about ten miles diſtance (three French leagues) the town of Crema was almoſt demoliſhed by the earthquake. The inhabitants ſaved themſelves by flight; and no people were remaining there, except the chaſſeurs of the 15th regiment, to prevent plunder. At 40 miles diſtance (about 12 French leagues) the village of Menguin, where there was a fine lake of about ten miles circumference, has been ſwallowed up in the lake; and not a ſingle perſon has been ſaved, nor does a ſingle veſtige of that village remain."

Letters from Verona ſtate, that they experienced an earthquake there on the 12th of May, which extended alſo to the Venetian territories, where, however, it was leſs violent than at Crema and Breſcia. In the latter city, three churches and twelve houſes were thrown down. Bergamo ſuſtained ſome damage alſo.

After the earthquake, which was felt in the ſtates of Parma, ſeveral fiſſures were formed on the heights and in the environs of the town of Bardi, from which a quantity of petroleum iſſued. This circumſtance has already produced a fall in the price of all the common oils, as it affords light at a much cheaper rate.

DEAF AND DUMB.

Some intereſting experiments were lately made in the Deaf and Dumb Inſtitute at Paris. It has been long known that moſt deaf and dumb perſons, when near large cannon which are fixed, or near churches when the bells are rung, give ſome indications of hearing. It has, however, not yet been determined with certainty, whether the impreſſions made on ſuch occaſions are produced merely by the violent motion or concuſſion of the air. The experiments lately made by C. Beyer on this ſubject, leave no doubt reſpecting this problem. The inſtruments which he employed did not emit very ſtrong

tones:

tones: he produced the moſt acute tones in the diatonic ſcale; and theſe were found to be the beſt calculated for exciting the organs of hearing. In the ſitting of March 31ſt laſt, the ſociety were deſirous of aſcertaining whether the ſenſation produced on the deaf and dumb by muſical inſtruments was an indefinite and obſcure perception, or if they were capable of diſtinguiſhing gradations in the tones preſented to their ears. For this purpoſe they were blindfolded, and different inſtruments which had been before employed were then made to ſound. The perſons who were the objects of this experiment not only ſhowed by uniform movements that they heard theſe ſounds, but they indicated by particular ſigns the kind of inſtruments employed; which was a certain proof that they were able to diſtinguiſh the different tones. In regard to one of them, the following remarkable phænomenon was obſerved: a ſingle tone made no impreſſion upon him, and it was neceſſary to repeat it ſeveral times before he was ſenſible of it, and able to diſtinguiſh it. It was thence concluded that it would be neceſſary for this young man to *learn to hear*, as perſons born blind who recover their ſight in conſequence of a chirurgical operation muſt gradually learn to ſee and to diſtinguiſh objects.

In conſequence of the experiments on deafneſs lately made at Paris by C. Beyer, from which it is concluded that the degree of deafneſs is to be aſcribed to a relaxation or too great diſtenſion of the membranum tympani, Dr. Gall, of Vienna, has examined the ſame ſubject, and, by anatomical reſearches on heads of ſeveral deaf and dumb perſons, has found that the organs of hearing are in general obſtructed in conſequence of ſwelled glands. He is therefore of opinion that antimony may be employed with advantage on perſons whoſe deafneſs has not attained to a very high degree.

DISCOVERY NEAR ROME.

During the latter end of April, ſome workmen employed in digging a trench for the purpoſe of planting a new vineyard at the ſeat of the chevalier Petrini, in the neighbourhood of Rome, found the ſkeleton of an animal, to which they paid little attention till they obſerved ſome bones of a monſtrous ſize. A thigh bone which was meaſured was two Paris feet four inches in circumference. Some teeth were found ſix inches in length, and which had a great reſemblance to others found in Siberia, and near the Ohio in America. Through the negligence of the workmen this intereſting object of natural hiſtory was nearly deſtroyed, great part of it having crumbled into duſt when expoſed to the air. There is reaſon to believe that this ſkeleton belonged to ſome of the monſtrous race of animals now extinct, ſuch as the mammouth.

PREMIUMS offered by the SOCIETY, *instituted at* London, *for the Encouragement of Arts, Manufactures, and Commerce, for the Year* 1802.

TO THE PUBLIC.

THE chief objects of the SOCIETY are to promote the Arts, Manufactures, and Commerce of this kingdom, by giving rewards for all such useful Inventions, Discoveries and Improvements, (though not mentioned in this book,) as tend to that purpose; and, in pursuance of this plan, the SOCIETY have already expended near FIFTY THOUSAND POUNDS, advanced by voluntary subscriptions of their members, and legacies bequeathed.

The manner in which this money has been distributed may be seen by applying to the Secretary or other officers of the SOCIETY, at their house in the *Adelphi*. The Register of the Premiums and Bounties they have given will shew the very great advantages which the Public have derived from this Institution.

The meetings of the SOCIETY are held every *Wednesday*, at seven o'clock in the evening, from the fourth *Wednesday* in *October* to the first *Wednesday* in *June*. The several Committees meet on other evenings in the week during the session.

In order still farther to promote the laudable views of this SOCIETY, it may be necessary to explain the mode by which its members continue to be elected.

Each member has the privilege, at any weekly meeting of the SOCIETY, of proposing any person who is desirous to become a member, provided such proposal is signed by three members of the SOCIETY.

Peers of the Realm or Lords of Parliament are, on their being proposed, immediately ballotted for; and the name, with the addition and place of abode, of every other person proposing to become a member, is to be delivered to the Secretary, who is to read the same, and properly insert the name in a list, which is to be hung up in the SOCIETY's room until the next meeting; at which time such person shall be ballotted for; and, if two-thirds of the members, then voting, ballot in his favour, he shall be deemed a *perpetual member*, upon payment of *Twenty Guineas* at one payment; or a *subscribing member*, upon payment of any sum not less than *Two Guineas* annually.

Every member is entitled to vote and be concerned in all the transactions of the SOCIETY, and to attend and vote at the several Committees. He has also the privilege of recommending two persons as Auditors, at the weekly meeting of the SOCIETY; and, by addressing a note to the Housekeeper, of introducing his friends to examine the various models, machines, and productions, in different branches of arts, manufactures, and commerce, for which rewards have been bestowed; and to inspect the magnificent series of moral and historical paintings so happily contrived and completed by JAMES BARRY, Esq. which, with some valuable busts and statues, decorate the Great Room. He has likewise the use of a valuable Library; and is entitled to the annual Volume of the SOCIETY's Transactions.

The time appointed for admission to the paintings or models, is from ten to two o'clock, *Sundays* and *Wednesdays* excepted.

PREMIUMS IN AGRICULTURE.

THE public are requested to take notice that the SOCIETY abide by the premiums offered in the 18th volume of their Transactions, for the setting of acorns, and planting of timber-trees, although such premiums are not here reprinted.

Class 1. FOREST-TREES.

To the person who shall have inclosed and planted, or set, the greatest number of acres (not less than ten) of land, that is incapable of being ploughed, such as the borders of rivers, the sides of precipices, and any land that has too many rocks, or that is not calculated to repay the expence of tillage, owing to the stiffness or poverty of the soil, the surface being too hilly, mountainous, or otherwise unfit for tillage, with the best sorts of forest-trees, namely, oak, Spanish chesnuts, ash, elm, beech, alder, willow, larch, spruce and silver fir, with or without screens of Scotch fir, adapted to the soil, and intended for timber trees, between the 1st of October, 1801, and the 1st of April, 1802, the gold medal.

2. For the second greatest quantity of land, not less than seven acres; the silver medal, or twenty guineas.

3. For the third greatest quantity of land, not less than five acres, the silver medal. A particular *account* of the methods used in making and managing the plantations, the nature of the soil, the probable number of each sort of plants, together with proper *certificates* that they were in a healthy and thriving state two years at least after making the plantation, to be delivered to the SOCIETY on or before the first Tuesday in November, 1805.

4, 5, 6. The same premiums are extended

one year further. *Certificates* to be produced on or before the first Tuesday in Nov. 1806.

7. Ascertaining the best method of raising Oaks. To the person who shall ascertain in the best manner, by actual experiments, the comparative merits of the different modes of raising oaks for timber, either from acorns set on land of the foregoing description properly dug or tilled, from acorns set by the spade or dibble, without digging or tillage, either on a smooth surface, or among bushes, fern, or other cover; or from young plants previously raised in nurseries, and transplanted; regard being had to the expense, growth, and other respective advantages of the several methods; the gold medal. The *accounts* and proper *certificates* that not less than one acre has been cultivated in each mode, to be produced to the Society on or before the first Tuesday in November, 1802.

8. The same premium is extended one year farther. The *accounts* and *certificates* to be produced on or before the first Tuesday in November, 1803.

9. Osiers. To the person who shall have planted, between the 1st of October, 1801, and the first of May, 1802, the greatest quantity of land, not less than five acres, with those kinds of willows, commonly known by the names of osier, Spaniard, new-kind, or French, fit for the purpose of basket-makers, not fewer than twelve thousand plants on each acre; the gold medal, or thirty guineas.

10. For the second greatest quantity of land, not less than three acres; the silver medal, or ten guineas. *Certificates* of the planting, and that the plants were in a thriving state five months at least after the planting, to be produced to the Society on or before the last Tuesday in November, 1802.

11. The same premiums are extended one year farther. *Certificates* to be produced on or before the last Tuesday in Nov. 1803.

*** *The candidates for planting all kinds of trees are to produce certificates that the respective plantations are properly fenced and secured, and particularly to state the condition of the plants at the time of signing such certificates. Any information which the candidates for the foregoing premiums may choose to communicate, relative to the methods made use of in forming the plantations, or promoting the growth of the several trees, or any other observations that may have occurred on the subject, will be thankfully received.*

12. Securing Plantations of Timber-trees, and Hedge-rows. To the person who shall give to the Society the most satisfactory account, founded on experience, of the most effectual, and least expensive method of securing young plantations of timber-trees, and hedge-rows, from hares and rabbits, as well as sheep and larger cattle, which at the same time shall be least subject to the depredations of wood-stealers, the silver medal, or twenty guineas. The *accounts* and *certificates* of the efficacy of the method to be produced to the Society on or before the first Tuesday in November, 1802.

13. The same premium is extended one year farther. The *accounts* and *certificates* to be produced on or before the first Tuesday in Nov. 1803.

14. Preventing the Blight, or Ravages of Insects, on Fruit-trees and Culinary Plants. To the person who shall discover to the Society the most effectual method of preventing the blight, or ravages of insects, on fruit-trees and culinary plants, superior to any hitherto known or practised, and verified by actual and comparative experiments; the gold medal, or thirty guineas. The *accounts*, with proper *certificates*, to be delivered to the Society on or before the second Tuesday in November, 1802.

15. The same premium is extended one year farther. The *accounts* and *certificates* to be delivered on or before the second Tuesday in November, 1803.

16. Removing the ill Effects of Blights, or Insects. To the person who shall discover to the Society the most effectual method of removing the ill effects of blights, or insects, on fruit-trees and culinary plants, superior to any hitherto known or practised, and verified by actual and comparative experiments; the gold medal, or thirty guineas. The *accounts* and *certificates* to be delivered to the Society on or before the first Tuesday in February, 1803.

17. Comparative Tillage. For the most satisfactory set of experiments, made on not less than eight acres of land, four of which to be trench-ploughed*, and four to be ploughed in the usual manner, in order to ascertain in what cases it may be adviseable to shorten the operations of tillage, by adopting one trench-ploughing, for the purpose of burying the weeds, instead of the method, now in common use, of ploughing and harrowing the land three or four times, and raking the weeds together and burning them; the gold medal, or forty guineas. It is required that every operation and expense attending each mode of culture be fully and accurately described, and that proper *certificates* of the nature and condition of the land on which the experiments are made, together with a circumstantial account of the appearance of the subsequent crops during their growth; and also of the quantity and weight of the corn and straw under each mode of culture, or, in case of a green crop, the weight of an average sixt en perches, be produced to the Society on or before the first Tuesday in Feb. 1803.

18. Comparative Culture of Wheat, broad-cast, drilled, and dibbled. For the best set of experiments made on not less than twelve acres, four of which to be sown broad-cast, four drilled, and four dibbled, the two latter in equi-distant rows, in order fully to ascertain which is the most advantageous mode of cultivating wheat; the gold medal, or forty guineas. It is required that every operation and expense of each mode of culture be fully described; and that proper *certificates* of the nature and condition of the land on which the experiments are made, to

* It is a common practice among gardeners, when they have a piece of very foul land, to dig it two spits, or about eighteen inches deep, shovelling the weeds to the bottom. This they call trenching.

gether with an *account* of the produce of the corn, the weight per bushel, and also of the straw, be produced to the Society on or before the first Tuesday in February, 1803.

19. SPRING WHEAT. To the person who, between the 10th of January and the 10th of April, 1802, shall cultivate the greatest quantity of wheat, not less than ten acres; the silver medal, or twenty guineas. It is required that the time of sowing and reaping be noticed; also a particular *account* of the species, cultivation, and expense attending it, with proper *certificates* of the nature and condition of the land on which the experiments were made, and the name of the crop, if any, which the same land bore the preceding year; together with an *account* of the produce, the weight per Winchester bushel; and a sample, not less than a quart, be produced to the Society on or before the second Tuesday in February, 1803.

It is supposed that sowing wheat early in the spring will not only allow more time to till the land but less for the growth of weeds; thus rendering the wheat as clean as a barley crop, and exhausting the soil much less than autumnal sowing. It may be seen in the 19th volume that the wheat usually sown in autumn may be put into the ground, with great success, so late as February or March, thus giving time to clear the ground from turnips, or to avoid a bad season.

20. BEANS AND WHEAT. To the person who shall have dibbled or drilled, between the 1st of December, 1801, and the 1st of April, 1802, the greatest quantity of land, not less than ten acres, with beans, in equi-distant rows, and hoed the intervals twice or oftener, and shall have sown the same land with wheat in the autumn of the year 1802; the silver medal, or twenty guineas. It is required that an account of the sort and quantity of beans, the time of dibbling or drilling, and of reaping or mowing them, the produce per acre threshed, the expense of dibbling or drilling, hand or horse hoeing, the distance of the rows, and the quality of the soil, together with *certificates* of the number of acres, and that the land was afterwards actually sown with wheat, be produced on or before the second Tuesday in March, 1803.

21. BEANS. To the person who, in the year 1801, shall discover and cultivate, either by the drill or dibbling-method, on not less than five acres, a species of horse-beans or tick-beans, that will ripen their seeds before the 21st of August; the silver medal, or twenty guineas. It is required that a particular account of the bean, the cultivation, and the expense attending it, with proper *certificates* of the nature and condition of the land on which the experiments are made, together with an *account* of the produce, the weight per Winchester bushel, and a sample of not less than a quart, be produced to the Society on or before the first Tuesday in December, 1802. It is apprehended that, if a bean should be brought into cultivation with the habits of the hotspur, or other early peas, that it would, in a great measure, escape the danger arising from the collier-insect, or other insects, and allow more time for the farmers to till the land for the subsequent crop of wheat. The *accounts* and *certificates* to be delivered on or before the first Tuesday in December, 1802.

22. The same premium is extended one year farther. The *accounts* and *certificates* to be delivered on or before the first Tuesday in Dec. 1803.

23. COMPARATIVE CULTURE OF TURNIPS. For the best set of experiments made on not less than eight acres of land, four of which to be sown broad-cast, and four drilled, to ascertain whether it is most advantageous to cultivate turnips by sowing them broad-cast and hand-hoeing them, or by drilling them in equi-distant rows, and hand or horse-hoeing the intervals; the silver medal, or twenty guineas. It is required that every operation and expense of each mode of culture be fully described, and that proper *certificates* of the nature and condition of the land, on which the experiments were made, together with the weight of the turnips grown, on a fair average sixteen perches of land, under each mode of culture, be produced to the Society on or before the first Tuesday in March, 1803. The object which the Society have in view in offering this premium is experimentally to ascertain the most advantageous method of growing turnips. To do this in a satisfactory manner, both the drilled and broad-cast crops should have the advantage of the most perfect cultivation, consequently the drilled crops should have the intervals between the rows worked by the horse or hand-hoe, or by both these implements; and the rows should be either weeded or hand-hoed, or both weeded and hand-hoed. The broad-cast crop should have every advantage which weeding and hand-hoeing can give it, consistently with leaving the soil a flat surface.

24. The same premium is extended one year farther. *Certificates* to be produced on or before the first Tuesday in March, 1804.

25. PARSNIPS. To the person who, in the year 1802, shall cultivate the greatest quantity of land, not less than five acres, with parsnips, for the sole purpose of feeding cattle or sheep; the gold medal, or thirty guineas. *Certificates* of the quantity of land so cultivated, with a particular *account* of the nature of the soil and weight of the produce on sixteen perches, and also of the condition of the cattle or sheep fed with the parsnips, and the advantages resulting from the practice, to be produced to the Society on or before the second day in Nov. 1803.

26. BUCK WHEAT. To the person who shall cultivate the greatest quantity of land with buck wheat, not less than thirty acres; the gold medal. It is required that the time of sowing and reaping be noticed, also a particular *account* of the species, cultivation, and expense attending it, the manner of reaping it, thrashing it, and housing the grain, with proper *certificates* of the nature and condition of the land on which the experiments were made, and the name of the crop, if any, which the same land bore the preceding year, together with an *account* of the produce, and a sample of the seed, not less than a quart, be produced to the Society on or before the second Tuesday in January, 1803.

27. For the next greatest quantity, not less than fifteen acres, on similar conditions; the silver medal. Information respecting its application to the feeding of cattle, hogs, and poultry, and other of its uses, is also desired. It is known to be particularly serviceable in furnishing honey to bees.

28. Raising Grass Seeds. To the person who shall raise the greatest quantity of each or any of the following named grass seeds, *viz.*—Meadow fox-tail (alopecurus pratensis), sweet scented vernal grass (anthoxanthum odoratum), Timothy grass, meadow Fescue grass, smooth-stalked meadow grass (poa pratensis) rough-stalked meadow grass (poa trivialis); the silver medal, or ten guineas. It is required that *certificates* from persons who have viewed them in a proper state, to identify that they are one or other of the seeds above-mentioned, indicating clearly the particular species, and noticing the quantity produced of such seeds, free from weeds or mixture of other grasses, together with proper samples of the seeds, be produced to the Society on or before the first day of February, 1803.

29. The same premium is extended one year farther. *Certificates* to be produced on or before the first day of February, 1804.

30. Rotation of Crops. To the person who shall, between the 10th of August, 1801, and the 10th of September, 1803, cultivate the greatest quantity of land, not less than forty acres, in the following rotation, *viz.*—1st, winter-tares; 2d, turnips; and 3d, wheat; and apply the two former crops, in the best and most farmer-like manner, to the rearing, supporting, and fattening horses, cattle, sheep, or hogs, on the land which produced the crops; the gold medal, or one hundred guineas.

31. For the next in quantity and merit, on not less than thirty acres; the silver medal, or fifty guineas.

32. For the next in quantity and merit, on not less than twenty acres; the silver medal. It is required that every operation and expense be fully described, and that satisfactory *certificates* of the nature and condition of the soil on which the crops have grown, together with an *account* of their appearance, the number of horses and cattle, sheep or hogs, fed by the two green crops, and, as near as possible, the improved value of the live stock by the consumption of those crops, and also the quantity of wheat per acre, and its weight per bushel, be produced to the Society on or before the first day of November, 1804.

It is presumed that very great advantages will arise to such agriculturists as shall adopt this rotation of crops on a dry soil. They will be enabled, with the addition of a few acres of turnip-rooted cabbage for spring-food, to keep such large flocks of sheep and herds of neat cattle as may secure a sufficient quantity of manure to fertilize their land in the highest degree, and in every situation. It is farther conceived that wheats which will bear sowing in the spring will be particularly suitable for this premium.

33. The same premium is extended one year farther. *Certificates* to be delivered on or before the first day of November, 1805.

34. Preserving Turnips. To the person who shall discover to the Society the best and cheapest method of preserving turnips perfectly sound, and in every respect fit for the purpose of supporting and fattening sheep and neat cattle, during the months of February, March, and April; the gold medal, or thirty guineas. It is required that a full and accurate *account* of the method employed, and the expense attending the process, together with *certificates* that the produce of four acres at the least have been preserved according to the method described, and applied to the feeding of sheep and neat cattle; that the whole were drawn out of the ground before the first day of February, in order to clear the greater part of it previous to its being prepared for corn, and to save the soil from being exhausted by the turnips; and also of the weight of an average sixteen perches of the crop; be produced to the Society on or before the first Tuesday in November, 1803.

N. B. *It is recommended to those who may be induced to try the necessary experiments for obtaining this and the following four premiums to consider the method employed for the preservation of potatoes in ridges, (which the growers call pies,) and also the propriety of adopting a similar method in cases where they are previously frozen. It is supposed that, in the latter instance, the addition of ice or snow, and the construction of the ridges upon a large scale, may be sufficient to preserve the freezing temperature till the vegetables are wanted for the use of cattle or sheep, at which time they may be thawed by immersion in cold weather, and the* rot *which a sudden thaw produces may be prevented.*

35. For the next in quantity and merit, on not less than two acres, the silver medal, or fifteen guineas.

36. Preserving Cabbages. To the person who shall discover to the Society the best and cheapest method of preserving drum headed cabbages perfectly sound, and in every respect fit for the purpose of supporting and fattening sheep and neat cattle during the months of February, March, and April; the gold medal, or thirty guineas.

37. For the next in quantity and merit, on not less than two acres, the silver medal, or fifteen guineas. Conditions the same as for preserving turnips, *Cl.* 34. And the *accounts* to be produced on or before the first Tuesday in November, 1803.

38. Preserving Carrots, Parsnips, or Beets. To the person who shall discover to the Society the best and cheapest method of preserving carrots, parsnips, or beets, perfectly sound, and in every respect fit for the purpose of supporting horses, and fattening sheep and neat cattle, during the months of February, March, and April; the silver medal, or fifteen guineas. Conditions the same as for preserving turnips, *Cl.* 34. and the *accounts* to be delivered in on or before the first day in November, 1803.

39. Preserving Potatoes. To the person who shall discover to the Society the best and cheapest method of preserving potatoes, two or more years, perfectly sound, without vegetating, and in every other respect fit for the purpose of sets and the use of the table, and, consequently, of supporting and fattening cattle; the silver medal, or twenty guineas. It is required, that a full and accurate *account* of the method employed, and the expense attending the process, with *certificates* that one hundred bushels at the least have been preserved according to the method described, and that one or more bushels of the same potatoes have been set, and produced a crop without any apparent diminution of their vegetative power; and also that they have been used at table, with entire satisfaction to the person who eat of them, together with a sample of one bushel, be sent to the Society on or before the first Tuesday in November, 1804.

40. Making Meadow-Hay in wet Weather. To the person who shall discover to the Society the best and cheapest method, superior to any hitherto practised, of making meadow-hay in wet weather; the gold medal, or thirty guineas. A full *account* of the method employed, and of the expense attending the process, with not less than fifty-six pounds of the hay; and *certificates* that at least the produce of six acres of land has been made according to the method described, and that the whole is of equal quality with the samples; to be produced on or before the first Tuesday in January, 1803.

41. Harvesting Corn in wet Weather. To the person who shall discover to the Society the best and cheapest method, superior to any hitherto practised, of harvesting corn in wet weather; the gold medal, or thirty guineas. A full *account* of the method employed, and of the expense attending the process, with not less than two sheaves of the corn, and *certificates* that at least the produce of ten acres has been harvested according to the method described, and that the whole is of equal quality with the samples, to be produced on or before the first Tuesday in January, 1803.

42. Ascertaining the component Parts of arable Land. To the person who shall produce to the Society the most satisfactory set of experiments to ascertain the due proportion of the several component parts of rich arable land, in one or more counties in Great Britain, by an accurate analysis of it; and who having made a like analysis of some poor arable land, shall, by comparing the component parts of each, and thereby ascertaining the deficiencies of the poor soil, improve a quantity of it, not less than one acre, by the addition of such parts as the former experiments shall have discovered to be wanting therein, and therefore probably the cause of its sterility; the gold medal, or forty guineas. It is required that the manurings, ploughings, and crops, of the improved land, be the same after the improvement as before; and that a minute *account* of the produce in each state, of the weather, and of the various influencing circumstances, together with the method made use of in analysing the soils, be produced, with proper *certificates* and the chemical results of the analysis, which are to remain the property of the Society, on or before the last Tuesday in November, 1803.

It is expected that a quantity, not less than six pounds, of the rich, of the poor, and of the improved soils, be produced with the *certificates*.

43. Improving Land lying waste. For the most satisfactory *account* of the best method of improving any of the following soils, being land lying waste or uncultivated, viz. clay, gravel, sand, chalk, peat-earth and bog, verified by experiments on not less than fifty acres of land; the gold medal, or thirty guineas.

44. For the next greatest quantity, not less than thirty acres, the silver medal, or twenty guineas. It is required that the land before such improvement be absolutely uncultivated, and in a great measure useless, and that, in its improved state, it be enclosed, cultivated, and divided into closes. *Certificates* of the number of acres, of the quality of the land so improved, with a full *account* of every operation and expense attending such improvement, the state it is in as to the proportion of grass to arable, and the average-value thereof, to be produced on or before the first Tuesday in February, 1803.

45. Manures. For the most satisfactory set of experiments, to ascertain the comparative advantages of the following manures, used as top-dressings on grass or corn land, viz. soot, coal-ashes, wood-ashes, lime, gypsum, night-soil, or any other fit article; the gold medal, or the silver medal and twenty guineas. It is required that the above experiments be made between two or more of the above-mentioned manures, and that not less than two acres of land be dressed with each manure. An *account* of the nature of the soil, quantity and expense of the manure and crops, with *certificates*, to be produced on or before the last Tuesday in February, 1803.

46. The same premium is extended one year farther. The *accounts* and *certificates* to be produced on or before the last Tuesday in February, 1804.

47. Gaining Land from the Sea. To the person who shall produce to the Society an account of the best method, verified by actual experiment, of gaining land from the sea, not less than twenty acres, on the coast of Great Britain or Ireland; the gold medal. *Certificates* of the quantity of land, and that the experiments were begun after the 1st of January, 1796, to be produced to the Society on or before the first Tuesday in October, 1802.

48. The same premium is extended one year farther. *Certificates* to be produced on or before the first Tuesday in October, 1803.

49. The same premium is extended one year farther. *Certificates* to be produced on or before the first Tuesday in October, 1804.

50. Machine for dibbling Wheat. To the person who shall invent a machine, superior to any hitherto known or in use, to answer the purpose of dibbling wheat, by which the holes for receiving the grain may be made at equal distances and proper depths; the silver medal,

or twenty guineas. The *machine*, with *certificates* that at least three acres have been dibbled by it, to be produced to the Society on or before the second Tuesday in January, 1803. Simplicity and cheapness in the construction will be considered as principal parts of its merit.

51. MACHINE FOR REAPING OR MOWING CORN. For inventing a machine to answer the purpose of mowing or reaping wheat, rye, barley, oats, or beans, by which it may be done more expeditiously and cheaper than by any method now practised, provided it does not shed the corn or pulse more than the methods in common practice, and that it lays the straw in such a manner that it may be easily gathered up for binding; the gold medal, or thirty guineas. The *machine*, with *certificates* that at least three acres have been cut by it, to be produced to the Society on or before the second Tuesday in December, 1802. Simplicity and cheapness in the construction will be considered as principal parts of its merit.

52. THRESHING-MACHINE. To the person who shall invent a machine by which corn of all sorts may be threshed more expeditiously, effectually, and at a less expense, than by any method now in use; the gold medal, or thirty guineas. The *machine* or a model with proper *certificates*, that such a machine has been usefully applied, that at least thirty quarters have been threshed by it, and of the time employed in the operation, to be produced to the Society on or before the last Tuesday in February, 1803.

53. DESTROYING THE GRUB OF THE COCKCHAFER. To the person who shall discover to the Society an effectual method, verified by repeated and satisfactory trials, of destroying the grub of the cockchafer, or of preventing or checking the destructive effects which always attend corn, peas, beans, and turnips, when attacked by those insects; the gold medal, or thirty guineas. The *accounts*, with proper *certificates*, to be produced on or before the first Tuesday in January, 1803.

54. DESTROYING WORMS. To the person who shall discover to the Society an effectual method, verified by repeated and satisfactory trials, of destroying worms, or of preventing the destructive effects they occasion on corn, beans, peas, or other pulse; the gold medal, or thirty guineas. The *accounts*, with proper *certificates*, to be produced to the Society on or before the first Tuesday in January, 1803.

55. DESTROYING THE FLY ON HOPS. To the person who shall discover to the Society an easy and efficacious method of destroying the fly on hops, superior to any hitherto known or practised, on not less than four acres of hop ground, the gold medal or thirty guineas. *Accounts* and *certificates* to be delivered to the Society on or before the first Tuesday in February, 1803.

56. CURE OF THE ROT IN SHEEP. To the person who shall discover to the Society the best and most effectual method of curing the rot in sheep, verified by repeated and satisfactory experiments; the gold medal, or fifty guineas. It is expected that the candidates furnish accurate *accounts* of the symptoms and cure of the disease, together with the imputed cause thereof, and the actual or probable means of prevention, which, with proper *certificates*, must be delivered to the Society on or before the first Tuesday in February, 1803.

57. PREVENTING THE ILL EFFECTS OF FLIES ON SHEEP. To the person who shall discover to the Society the most effectual method of protecting sheep from being disturbed and injured by flies; the silver medal, or twenty guineas. It is required that the method be ascertained by repeated experiments, and that a *certificate* of its efficacy be delivered to the Society on or before the first Tuesday in December, 1802.

58. PROTECTING SHEEP. To the person who, in the year 1802, shall protect the greatest number of sheep, not fewer than one hundred, by hovels, sheds, or any other means, and give the most satisfactory account, verified by experiment, of the advantages arising from the practice of protecting sheep from the inclemency of the weather, by hovels, sheds, or any other means; the silver medal, or twenty guineas. A particular *account* of the experiments made, with the advantages arising therefrom, together with the expense, and *certificates* of its utility, to be produced to the Society on or before the first Tuesday in March, 1803.

59. The same premium is extended one year farther. The *accounts* and *certificates* to be delivered on or before the first Tuesday in March, 1804.

N. B. It is required that the *certificates* shall specify the length of time the sheep were so protected, and the manner in which they were maintained during that time; together with the general method of managing them.

60. IMPROVING THE CONDITION OF THE LABOURING POOR, BY ERECTING COTTAGES, AND APPORTIONING LAND. To the person who, in the year 1801, shall erect the greatest number of cottages for the accommodation of the labouring poor, and apportion not less than two acres of land to each cottage; the gold medal. The *accounts* and *certificates* to be delivered to the Society on or before the first Tuesday in February, 1803.

61. The same premium is extended one year farther. The *accounts* and *certificates* to be delivered to the Society on or before the first Tuesday in February, 1804.

62. The same premium is extended one year farther. The *accounts* and *certificates* to be delivered to the Society on or before the first Tuesday in February, 1805.

63. IMPROVING THE CONDITION OF THE LABOURING POOR BY APPORTIONING LAND TO COTTAGES. To the person who, in the year 1802, shall apportion to the greatest number of cottages, already built upon his or her estate, any quantity of land, not less than two acres to each cottage, for the better accommodation of the respective inhabitants; the gold medal. The *accounts* of the number of cottages, and of the quantity of land apportioned to each, to be delivered to the Society, with proper *certificates*, on or before the first Tuesday in February, 1803.

64. The same premium is extended one year farther. The *accounts* and *certificates* to be de-

livered on or before the first Tuesday in February, 1804.

65. The same premium is extended one year farther. The *accounts* and *certificates* to be delivered on or before the first Tuesday in February, 1805.

66. Raising Water for the Irrigation of Land. To the person who shall discover to the Society the cheapest and most effectual method of raising water in quantities sufficient to be beneficially employed for the purposes of irrigating land, superior to and cheaper than any other method now in use; the gold medal, or thirty guineas. A model on a scale of one inch to a foot, with *certificates* that a machine at large on the same construction has been used, specifying the quantity of water delivered in gallons per hour, and the height to which it was raised, to be produced to the Society on or before the first of March, 1803.

The same premium is extended one year farther. *Certificates* to be produced on or before the first of March, 1804.

67. Culture of Hemp in certain parts of Scotland. The Society for the Encouragement of Arts, Manufactures, and Commerce wishing to encourage the growth of hemp for the use of the navy, in certain parts of Scotland, comprehending the whole county of Argyle, that part of Perthshire situated to the north of the river Tay, and west of the Military Road (see Ainslie's Map of Scotland) leading from Logierait to the County of Inverness, and such other parts of Scotland as lie north of Inverness-shire, offers to the person who shall sow with hemp, in drills at least eighteen inches asunder, the greatest quantity of land in the above mentioned district, not less than fifty acres statute measure, in the year 1802, and shall at the proper season cause to be plucked the summer hemp (or male hemp bearing no seed) and continue the winter hemp (or female hemp bearing seed) on the ground until the seed is ripe; the gold medal, or fifty guineas.

67*. To the person who shall sow with hemp, (in drills at least eighteen inches asunder) the next greatest quantity of land in the same above-mentioned district, not less than twenty-five acres statute measure, in the year 1802, and shall at the proper season cause the same to be plucked as above-mentioned; the silver medal, or twenty-five guineas. *Certificates* of the number of acres, of the distance of the drills, of the plucking of the hemp, with a general account of the soil, cultivation, and produce, to be delivered to the Society, along with fourteen pounds of the hemp, and two quarts of the seed, on or before the second Tuesday in January, 1803.

PREMIUMS FOR DISCOVERIES AND IMPROVEMENTS IN CHEMISTRY, DYING, AND MINERALOGY.

68. Preserving Seeds of Vegetables. For the best method of preserving the seeds of plants in a state fit for vegetation a longer time than has hitherto been practised, such method being superior to any known to the public, and verified by sufficient trial, to be communicated to the Society on or before the first Tuesday in December, 1802; the gold medal, or thirty guineas.

69. Preventing the Dry-Rot in Timber. To the person who shall discover to the Society the cause of the dry-rot in timber, and disclose a certain method of prevention superior to any hitherto known; the gold medal, or thirty guineas. The *accounts* of the cause, and method of prevention, confirmed by repeated experiments, to be produced to the Society on or before the second Tuesday in December, 1802.

70. Preserving salted Provisions from becoming rancid or rusty. To the person who shall discover to the Society the best, cheapest, and most efficacious method of preserving salted provisions from growing rancid or rusty; the gold medal, or thirty guineas. A full description of the method, with proper *certificates* that it has been found, on repeated trials, to answer the purpose intended, to be produced to the Society on or before the first Tuesday in February, 1803.

71. Clearing Feathers from their animal Oil. To the person who shall discover to the Society the best and most expeditious method, superior to any hitherto practised, of clearing goose-feathers from their offensive animal oil, for the use of upholders, in making beds, cushions, &c. the silver medal, or twenty guineas. A quantity of such feathers unstripped and so cleared, not less than forty pounds weight, with a full *account* of the process, to be produced to the Society on or before the first Tuesday in February, 1803.

72. Refining Whale or Seal Oil. For disclosing to the Society an effectual method of purifying whale or seal oil from the glutinous matter that incrusts the wicks of lamps and extinguishes the light, though fully supplied with oil; the gold medal, or fifty guineas. It is required that the whole of the process be fully and fairly disclosed, in order that satisfactory experiments may be made by the Society to determine the validity of the claim; and *certificates* that not less than twenty gallons have been purified according to the process delivered in, together with two gallons of the oil, in its unpurified state, and two gallons so refined, be produced to the Society on or before the second Tuesday in February, 1803.

73. Manufacturing Tallow-Candles. To the person who shall discover to the Society a method of hardening or otherwise preparing tallow, so that candles may be made of it which will burn as clear and with as small a wick as wax candles, without running, and may be afforded at a less expense than any at present made with spermaceti; the gold medal, or thirty guineas. *Certificates* that 112lb. of such tallow have been made into candles, and 12lb. of the candles made thereof, to be produced to the Society on or before the second Tuesday in January, 1803.

74. Candles from Resin or other Substances. To the person who shall discover to

the Society the best method of making candles of resin, or any other substance, fit for common use, at a price much inferior to those made of tallow only; the gold medal, or thirty guineas. Six pounds at least of the candles so prepared, with an *account* of the process, to be delivered to the Society on or before the first Tuesday in December, 1802.

75. Method of separating Sugar in a solid Form from Treacle. To the person who shall discover to the Society the best method of separating sugar from treacle in a solid form, at such an expense as will render it advantageous to the public; the gold medal, or fifty guineas. A quantity of the sugar so prepared in a solid form, not less than thirty pounds weight, with an *account* of the process, and *certificates* that not less than one hundred weight has been prepared, to be produced to the Society on or before the first Tuesday in February, 1803.

76. PROOF-SPIRIT. To the distiller who, in the year 1802, shall make the greatest quantity, not less than one hundred gallons, of a clean marketable spirit, from articles not the food of man or cattle, equal in strength or quality to the proof-spirit now in use, and at a rate not higher than the spirit produced from corn or melasses; the gold medal, or one hundred guineas. Ten gallons of the spirit, together with proper *certificates*, and a full *account* of the expense and mode of making it, to be produced to the Society on or before the first Tuesday in January, 1803.

77. Increasing Steam. To the person who shall invent and discover to the Society a method, verified by actual experiments, of increasing the quantity or force of steam, in steam-engines, with less fuel than has hitherto been employed, provided that in general the whole amount of the expenses in using steam-engines may be considerably lessened; the gold medal, or thirty guineas. To be communicated to the Society on or before the first Tuesday in Jan. 1803.

78. Substitute for Tar. To the person who shall invent and discover to the Society the best substitute for Stockholm tar, equal in all its properties to the best of that kind, and prepared from materials the produce of Great Britain; the gold medal, or one hundred guineas. A quantity of the substitute, not less than one hundred weight, with *certificates* that at least one ton has been manufactured, and that it can be afforded at a price not exceeding that of the best foreign tar, together with an *account* of the process, to be delivered to the Society on or before the first Tuesday in March, 1803.

79. Preparation of Tan. To the person who shall prepare in the most concentrated form, so as to be easily portable, and at a price applicable to the purposes of manufactures, the largest quantity, not less than one hundred weight of the principle called by the French *tannin*, which abounds in oak-bark and many other vegetable substances; the gold medal, or fifty guineas. *Certificates* of the above quantity having been prepared, and a sample of not less than 28 lb. to be produced to the Society on or before the last Tuesday in January, 1803.

80. Preparation of a red Stain for cotton Cloth. To the person who shall communicate to the Society, the cheapest and most effectual method of printing or staining cotton cloths with a red colour, by an immediate application of the colouring-matter to the cloth, equally beautiful and durable with the red colours now generally procured from decoctions of madder; the gold medal, or thirty guineas. *Certificates* that the above process has been advantageously used on ten pieces of callico, each twenty-one yards or upwards in length, one piece of the callico so printed, a quart of the colour in a liquid state, and a full *account* of the preparation and application, to be produced to the Society on or before the second Tuesday in January, 1803.

81. Preparation of a green Colour for printing cotton Cloth. To the person who shall communicate to the Society the best and cheapest method of printing with a full green colour on cotton cloth, by an immediate application of the colouring-matter from a wooden block to the cloth, equally beautiful and durable as the colours now formed from the complicated process of the decoction of weld on alumine and the solutions of indigo by earths or alcaline salts; the gold medal, or thirty guineas. *Certificates* and conditions as for premium 80.

82. Substitute for the Basis of Paint. To the person who shall produce to the Society the best substitute, superior to any hitherto known, for the basis of paint, equally proper for the purpose as the white lead now employed; such substitute not to be of a noxious quality, and to be afforded at a price not materially higher than that of white lead; the gold medal, or one hundred guineas. A quantity of the substitute, not less than 50 lb. weight, with an *account* of the process used in preparing it, and *certificates* that at least one hundred weight has been manufactured, to be produced to the Society on or before the first Tuesday in January, 1803.

83. Red Pigment. To the person who shall discover to the Society a full and satisfactory process for preparing a red pigment, fit for use, in oil or water, equal in tone and brilliancy to the best carmines and lakes now known or in use, and perfectly durable; the gold medal, or thirty guineas. One pound weight of such colour, and a full disclosure of its preparation, to be produced to the Society on or before the first Tuesday in February, 1803.

N. B. It is not required that the colour should resist the action of fire or chemical applications, but remain unaltered by the common exposure to strong light, damps, and noisome vapours.

84. Ultramarine. To the person who shall prepare an artificial ultramarine, equal in colour, brilliancy, or durability, to the best prepared from lapis lazuli, and which may be afforded at a cheap rate; the gold medal, or thirty guineas. The conditions are the same as in the preceding premium for the red pigment.

85. Analysis of British Minerals. To the person who shall communicate to the Society,

the most correct analysis of any mineral production of Great Britain, hitherto either unexamined or not examined with accuracy; the gold medal. The analysis and sufficient specimens to be produced to the Society on or before the first Tuesday in January, 1803.

86. Preparation of sulphuric Acid from Sulphur without the Use of any nitric Salt. To the person who shall prepare the largest quantity (not less than one ton) of sulphuric acid from sulphur, without any nitric salt, of a specific gravity, not inferior to the best sulphuric acid of commerce; the gold medal, or fifty guineas. *Certificates* that not less than the above quantity of such an acid has been prepared, together with a sample, to be produced to the Society on or before the first Tuesday in January, 1803.

87. Preparation of any alkaline or earthy Nitrate. To the person who shall prepare, in Great Britain, the largest quantity, not less than one hundred weight, of any salt of nitric acid, with either earths or alkalies, by a method superior to those hitherto practised; the gold medal, or one hundred guineas. *Certificates* of the above quantity having been prepared, and a sample of not less than 28lb. to be produced to the Society on or before the last Tuesday in January, 1803.

88. Fine Bar-iron. To the person, in Great Britain, who shall make the greatest quantity of bar-iron, not less than ten tons, with coak, from coak-pigs, equal in quality to the best iron imported from Sweden or Russia, and as fit for converting into steel; the gold medal, or fifty guineas. Samples, not less than one hundred weight, with *certificates* that the whole quantity is of equal quality, to be produced to the Society on or before the first Tuesday in January, 1803.

89. Preserving Iron from Rust. To the person who shall invent and discover to the Society a cheap composition, superior to any now in use, which shall effectually preserve wrought iron from rust, the gold medal, or fifty guineas. A full description of the method of preparing the composition, with *certificates* that it has stood at least two years unimpared, being exposed to the atmosphere during the whole time, to be produced to the Society, with ten pounds weight of the composition, on or before the first Tuesday in January, 1803.

90. Refining Block-tin. To the person who shall discover to the Society the best method of purifying or refining block-tin, so as to render it fit for the finest purposes to which grain-tin is now applied, and not higher in price; the gold medal, or fifty guineas. *Certificates* that not less than three tons have been refined or purified, with a full detail of the process, and a quantity, not less than one hundred weight, of the tin so refined, to be produced to the Society on or before the first Tuesday in January, 1803.

91. Glazing Earthen-Ware without Lead. To the person who shall discover to the Society the cheapest, safest, most durable, and most easily-fusible, composition, fit for the purpose of glazing the ordinary kinds of earthen-ware, without any preparation of lead, and superior to any hitherto in use; the gold medal, or thirty guineas. Specimens of the ware so glazed, with proper *certificates* of its having succeeded, and a sample of the materials made use of, to be produced to the Society on or before the first Tuesday in February, 1803.

92. Refining Copper from the Ore. To the person who shall discover to the Society the best method of separating, purifying, and refining copper from the ore, so as to render it fit for the finest purposes to which fine copper is now applied, and by a process superior to any hitherto known or in use, and not higher in price; the gold medal, or fifty guineas. *Certificates* that not less than three tons have been so prepared or refined, and a quantity not less than one hundred weight of the copper so refined, to be produced to the Society on or before the first Tuesday in February, 1803.

93. Mineralogical Map of England and Wales. To the person who shall complete and publish an accurate mineralogical map of England and Wales, on a scale of not less than ten miles to an inch, containing an account of the situation of the different mines therein, and describing the kinds of minerals thence produced; the gold medal, or fifty guineas. *Certificates* of the accuracy of such map, together with the map, to be produced to the Society on or before the first Tuesday in February, 1804. The map to remain the property of the Society.

94. Mineralogical Map of Ireland. The same premium is offered for a mineralogical map of Ireland on similar conditions.

95. Mineralogical Map of Scotland. The same premium is offered for a mineralogical map of Scotland on similar conditions.

96. Natural History. To the author who shall publish, in the year 1802, the natural history of any county in England or Wales; the gold medal, or fifty guineas. It is required that the several natural productions, whether animal, vegetable, or mineral, peculiar to the county, or found therein, be carefully and specifically arranged and described, in order that the public may be enabled to judge what arts or manufactures are most likely to succeed in such county. The work to be delivered to the Society on or before the last Tuesday in January, 1803.

PREMIUMS IN POLITE ARTS.

97. Honorary Premiums for Drawing, by Nobility. For the best drawing, of any kind, made with water-colours, crayons, chalk, black lead, pen, Indian ink, or bister, by young gentlemen under the age of twenty-one, sons or grandsons of peers, or peeresses in their own right, of Great Britain or Ireland, to be produced on or before the first Tuesday in March, 1803; the honorary medal of the Society in gold.

98. The same in silver for the next in merit.

99, 100. The same premiums will be given, on

the like conditions, to young ladies, daughters or grand-daughters of peers, or peeresses in their own right, of Great Britain or Ireland.

101. Honorary Premiums for Drawing, by Gentlemen. For the best drawing, of any kind, made with water-colours, crayons, chalk, black-lead, pen, Indian ink, or bister, by young gentlemen under the age of twenty-one, to be produced on or before the first Tuesday in March, 1803; the gold medal.

102. For the next in merit, the silver medal.

103, 104. The same premiums will be given for drawings by young ladies.

N. B. As the foregoing honorary premiums are intended only for such of the nobility and gentry as may hereafter become patrons or patronesses of the arts; persons professing any branch of the polite arts, or any business dependent on the arts of design, or the sons or daughters of such persons, will not be admitted candidates in these classes.

105. Drawings of Outlines. For the best outline, after an original group or cast, in plaster, of human figures, by persons of either sex, under the age of sixteen, the principal figure not less than twelve inches; to be produced on or before the third Tuesday in February, 1803; the greater silver pallet.

106. For the next in merit; the lesser silver pallet.

N. B. These drawings are to be made on paper, and the original either to be produced to the Society, or to be referred to for their examination.

107. Drawings of Landscapes. For the best drawing of a landscape after nature, by persons of either sex, under twenty-one years of age, to be produced on or before the third Tuesday in February, 1803; the greater silver pallet.

108. For the next in merit, the lesser silver pallet. Each candidate must mention, on the front of the drawing, whence the view was taken; and the drawings must be made with chalk, pen, Indian ink, water-colours, or bister.

109. Historical Drawings. For the best historical drawing, being an original composition, of five or more human figures; the height of the principal figure not less than eight inches; to be made with crayons, chalk, black lead, pen, Indian ink, water-colours, or bister, and to be produced on or before the third Tuesday in February, 1803; the gold pallet.

110. For the next in merit; the greater silver pallet.

111. Chints Patterns for Calico-Printers. For the best original pattern in a new taste, of light or dark ground chints for garment-work, fit for the purposes of calico-printers, by persons of either sex; the gold medal. To be produced to the Society on or before the second Tuesday in January, 1803; the pattern to which the premium is adjudged to remain the property of the Society.

112. For the next in merit; the silver medal, on similar conditions.

113. Copper-plate Patterns for Calico-Printers. For the best pattern, in a new stile, fit for the purposes of calico-printers for garment work; the silver medal. To be produced to the Society on or before the second Tuesday in January, 1803. The pattern to which the premium is adjudged to remain the property of the Society.

114. Line Engravings of Landscapes. For the best line engraving of a landscape, published in the year 1803, the size of the engraving not less than eighteen inches by fourteen; the gold medal. To be produced to the Society on or before the last Tuesday in January, 1804; and the impression to which the premium is adjudged to remain the property of the Society.

115. For the next in merit; the silver medal, on similar conditions.

116. Line Engravings of Historical Subjects. For the best line engraving published in the year 1802, of an historical subject, the size of the engraving not less than eighteen inches by fourteen; the gold medal.

117. For the next in merit; the silver medal. Conditions, &c. the same as in classes 114 and 115.

118 Model in Clay or Plaster. For the best model in clay or plaster of an ornamental design for the purpose of embellishing works of Architecture; the silver medal, or twenty guineas. To be produced to the Society on or before the last Tuesday in January, 1803. The model not to be less than thirty inches by twelve.

THE FOLLOWING PREMIUM (CLASS 119,) IS OFFERED IN CONFORMITY TO THE WILL OF THE LATE JOHN STOCK, OF HAMPSTEAD, Esq.

119. Ornamental Drawings for Architectural Designs. For the best ornamental drawing for the purpose of embellishing architectural designs; a silver medallion with the following engraved inscription: *The Premium given by the Society for the Encouragement of Arts, Manufactures, and Commerce, in conformity to the Will of John Stock, of Hampstead, Esq.* The drawing to which the premium is adjudged to remain the property of the Society.

120. For the best model in clay or plaster of a design for the same purpose; the silver medal. The performances in these two classes not to be less than thirty inches by twelve, to be made by persons under the age of twenty-one years. To be produced to the Society on or before the last Tuesday in January, 1803.

121. Perspective Drawings of Machines. For the best perspective drawing of machines by persons under eighteen years of age; the greater silver pallet. To be produced to the Society on or before the last Tuesday in January, 1803.

122. For the next in merit; the lesser silver pallet, on similar conditions.

123. Engraving on Wood, or Metal.

BLOCKS. For the best engraving on wood, or metal blocks, of a subject or allegorical decoration for a volume of the Society's Transactions, proper to be prefixed to the premiums offered by the Society, and capable of being worked with the letter press; the gold medal. The engraved wood or metal block, and two or more impressions from it, to be produced to the Society on or before the second Tuesday in February, 1803, and the engraved wood or metal block to which the premium is adjudged to remain the property of the Society. The engraving to be of a proper size to form an octavo page in the volume.

124. For the next in merit; the silver medal or similar conditions.

125. STATUARY MARBLE. To the person who shall discover, within Great Britain or Ireland, a quarry of white marble fit for the purposes of statuary, and equal in all respects to those kinds now imported from Italy; the gold medal, or one hundred pounds. A block of at least three feet in length, two in height, and two in width, with an account of the situation of the quarry, and *certificates* of its possessing considerable extent, to be produced to the Society, on or before the first Tuesday in February, 1803.

N. B. In order to prevent useless expense or trouble to the claimant in forwarding so large a block, the Society will be ready to examine any smaller specimen of the marble, and express their opinion of its value to the candidate before the block required by the above premium is produced.

126. BRONZES. For the best drapery-figure or group cast in bronze; if a single figure, not less than twelve inches high; and, if a group, not less than nine inches; and which will require the least additional labour to repair; the gold medal, or the silver medal and twenty guineas. The cast to be exhibited to the Society before it is begun to be repaired, with the original figure or group, on or before the first Tuesday in February, 1802, together with a full explanation of the whole process.

PREMIUMS FOR ENCOURAGING AND IMPROVING MANUFACTURES.

127. MACHINE FOR CARDING SILK. For the best machine, superior to any now in use, for carding waste silk equally well as by hand; to be produced, together with a specimen of the cardings, on or before the first Tuesday in November, 1802; the silver medal, or twenty guineas.

128. CLOTH FROM HOP-STALKS, &c. To the person who shall produce to the Society the greatest quantity, not less than thirty yards of cloth at least twenty-seven inches wide, made in Great Britain, of hop-stalks or bines, or other raw vegetable substances, the produce of Great Britain or Ireland, superior to any hitherto manufactured from such substances, and which can be generally afforded as cheap as cloth of equal quality and appearance now made from hemp, flax, or cotton, and much finer in quality than any hitherto manufactured in England from hop-stalks, &c. the gold medal, or thirty guineas. One pound of the thread of which the cloth is made, and thirty yards of the cloth, together with proper *certificates* that the whole is manufactured from hop-stalks or bines, &c to be produced to the Society on or before the first Tuesday in December, 1802.

N. B. The Society is already in the possession of cloth made in England from hop-stalks or bines, which may be inspected by application to the housekeeper.

129. WICKS FOR CANDLES OR LAMPS. To the person who shall discover to the Society a method of manufacturing hop-stalks or bines, or any other cheap material, the growth of Great Britain, so as to render them equally fit for the purpose of supplying the place of cotton, for wicks of candles or lamps; twenty guineas. Samples, not less than five pounds weight, of the wicks so prepared to be produced to the Society, with *certificates* that the whole quantity is equal in quality to the sample, on or before the second Tuesday in January, 1803.

130. PAPER FROM RAW VEGETABLE SUBSTANCES. To the person, in Great Britain, who shall, between the first of January, 1802, and the first of January, 1803, make the greatest quantity, and of the best quality, (not less than ten reams) of good and useful paper, from raw vegetable substances, the produce of Great Britain or Ireland, of which one hundred weight has not been used in manufacturing paper previous to January, 1801, superior to any hitherto manufactured from such substances, and which can be generally afforded as cheap as paper of equal quality and appearance now made from rags; twenty guineas.

N. B. The object of the Society being to add to the number and quantity of raw materials used in this manufacture, it is their wish to include every useful sort of paper, and to introduce such natural products as can be easily and cheaply procured in great quantities. The Society are in possession of two volumes containing a great variety of specimens of paper made from raw vegetable substances, *viz.*—nettles, potatoe-hawlm, poplar, hop-bines, &c. which volumes may be inspected by any person on application to the housekeeper.

Certificates of the making such paper, and one ream of the paper, to be produced on or before the second Tuesday in January, 1803.

131. TRANSPARENT PAPER. To the person who shall discover to the Society a method of making paper from the pulp that shall be perfectly transparent, and of a substance and body equal to fools-cap, that shall take and bear common writing ink with the same facility and correctness as writing paper generally in

use; the silver medal, or twenty guineas. *Certificates* of the making such paper, an *account* of the process, and one ream of the paper, to be produced on or before the second Tuesday in January, 1803.

132. Taking Porpoises. To the people in any boat or vessel, who, in the year 1802, shall take the greatest number of porpoises on the coast of Great Britain, by gun, harpoon, or any other method, not fewer than thirty, for the purpose of extracting oil from them; the gold medal, or thirty pounds. *Certificates* of the number, signed by the persons to whom they have been sold or delivered for the purpose of extracting the oil, to be produced to the Society on or before the last Tuesday in January, 1803.

133. Oil from Porpoises. To the person who shall manufacture the greatest quantity of oil from porpoises taken on the coast of Great Britain, in the year 1802, not less than twenty tons; the gold medal, or thirty pounds. *Certificates* of the oil having been made from porpoises actually caught on the coast of Great Britain, and two gallons of the oil as a sample, to be produced to the Society on or before the last Tuesday in February, 1803.

PREMIUMS IN MECHANICS.

134. Gunpowder-Mills. To the person who, in the year 1802, shall invent and bring to perfection the most effectual method of so conducting the works of gunpowder-mills, in the business of making gunpowder, as to prevent explosion; the gold medal, or one hundred guineas. *Certificates* and *accounts* of the method having been put in practice in one or more gunpowder-mills in this kingdom, and that it promises, in the opinion of the best judges concerned in such works, to answer the purpose intended, to be produced to the Society on or before the first Tuesday in Feb. 1803.

N. B. As an encouragement to persons to turn their thoughts to improvements of this nature, if any should be made on the present method of conducting the business of gunpowder making, which fall short of the total prevention of explosion, and they are sent to the Society for the sake of humanity, the papers so sent in will receive due consideration, and such bounty or reward will be bestowed thereon as they appear to merit.

135. Transit-Instrument. To the person who shall invent and produce to the Society a cheap and portable transit-instrument, which may easily be converted into a zenith-sector, capable of being accurately and expeditiously adjusted for the purpose of finding the latitudes and longitudes of places, and superior to any portable transit-instrument now in use; the gold medal, or forty guineas. To be produced on or before the last Tuesday in Jan. 1803.

136. Taking Whales by the Gun-Harpoon. To the person who, in the year 1802, shall strike the greatest number of whales, not fewer than three, with the gun-harpoon; ten guineas. Proper *certificates* of the striking such whales, and that they were actually taken in the year 1802, signed by the master, or by the mate when the claim is made by the master, to be produced to the Society on or before the last Tuesday in December, 1802.

137. Family Mills. To the person who shall invent and produce to the Society the best constructed mill for grinding corn for the use of private families, or parish-poor; the construction to be such as to render the working of the mill easy and expeditious, and superior to any hitherto in use; the gold medal, or thirty guineas. The mill, and *certificates* of its having been used to good effect, to be produced to the Society on or before the first Tuesday in February, 1803.

N. B. Cheapness and simplicity will be considered an essential parts of its merit; and the mill, or the model, to remain with the Society.

138. Machine for raising Coals, Ore, &c. &c. To the person who shall invent a machine for raising coals, ore, &c. from mines, superior to any hitherto known or in use, and which shall produce the effect at a less expense than those already known or in use; the gold medal, or fifty guineas. A model of the machine, made on a scale of not less than one inch to a foot, with a *certificate* that a machine at large on the same construction has been advantageously used, to be produced to the Society on or before the second Tuesday in February, 1803.

139. Machine for raising Water. To the person who shall invent a machine on a better, cheaper, and more simple construction than any hitherto known or in use, for raising water out of wells, &c. from a depth of not less than fifty feet; the gold medal, or forty guineas. *Certificates* of the performance of the machine, and a model of it, on a scale of not less than one inch to a foot, to be produced to the Society on or before the first Tuesday in February, 1803.

140 Machine for making Bricks. To the person who shall invent the best and cheapest machine for making bricks, superior to any hitherto known or in use, whereby the labour and expense of making bricks in the usual mode, by hand, may be greatly diminished; forty guineas. A model, with *certificates* that a machine at large, on the same construction, has been used to good effect for the purpose of making bricks, and that at least one hundred thousand statute-bricks have been made therewith, to be produced to the Society on or before the first Tuesday in March, 1803.

141. Boring and Blasting Rocks. To the person who shall discover to the Society a

more simple, cheap, and expeditious method than any hitherto known or in use of boring and blasting rocks in mines, shafts, wells, &c.; the gold medal, or thirty guineas. *Certificates* of the method having been practised with success, with a full description thereof, to be delivered to the Society on or before the first Tuesday in January, 1803.

142. HEATING ROOMS FOR THE PURPOSES OF MANUFACTURERS. To the person who shall invent and discover to the Society a method of heating rooms, superior to any hitherto known or in use, and at a moderate expense, for the purposes of painters, japanners, and other manufacturers, so as to avoid the necessity of iron or copper tunnels going through the rooms to convey the smoke, whereby the danger from such tunnels may be prevented; the gold medal, or forty guineas. A model, or complete drawing and description of the method, with *certificates* that it has been successfully practised, to be delivered to the Society on or before the last Tuesday in March, 1803.

143. IMPROVED VENTILATION. To the person who shall invent and produce to the Society a mode of permanently ventilating the apartments in hospitals, workhouses, and other crowded places, superior to any now known or used; the gold medal, or fifty guineas. A model of the apparatus, and a full account of the means by which the effect has been produced, with proper *certificates*, to be delivered to the Society on or before the last Tuesday in February, 1803

144. MILL STONES. To the person who shall, between the first of February, 1802, and the first of February, 1803, prepare and bring into use the greatest number of mill stones, taken from any quarry in the United Kingdoms, equal in quality to the French burrs, not less than thirty pairs; the gold medal, or thirty guineas. *Certificates* that the said mill stones were all taken from the same quarry, with their prices and dimensions, that they are equal to the French burr, not less than three feet eight inches diameter, and are actually in use, to be produced to the Society on or before the third Tuesday in February, 1803.

145. For the next greatest quantity, not less than twenty-five pair; the silver medal, or fifteen guineas, on similar terms.

146. PREVENTING ACCIDENTS FROM HORSES FALLING WITH TWO-WHEELED CARRIAGES. To the person who shall invent and produce to the Society a method superior to any hitherto known or in use, to prevent accidents from the falling of horses with two-wheel carriages, especially on steep declivities; the silver medal, or fifteen guineas. A model of the apparatus, and a full account of the means by which the effect has been produced, with proper *certificates* that the same has been used with success, to be delivered to the Society on or before the second Tuesday in Jan. 1803.

147. CLEARING THE TURNPIKE AND OTHER ROADS IN WINTER FROM MUD, AND IN SUMMER FROM DUST. To the person who shall discover to the Society the most effectual and the cheapest method, verified by experiments, of clearing the turnpike and other roads of great resort, in winter from mud, and in summer from dust, or most effectually preventing the accumulation of either; the gold medal, or fifty guineas.

148. For the second best account; the silver medal, or twenty guineas. It is required that an accurate *account* of the method used, and every expense attending it, together with satisfactory *certificates* of its being effectual, be delivered to the Society on or before the first Tuesday in March, 1803.

PREMIUMS OFFERED FOR THE ADVANTAGE OF THE BRITISH COLONIES.

149. NUTMEGS For the greatest quantity of merchantable nutmegs, not less than ten pounds weight, being the growth of his Majesty's dominions in the West Indies, or any of the British settlements on the coast of Africa, or the several islands adjacent thereto, and equal to those imported from the islands of the East Indies; the gold medal, or one hundred guineas. Satisfactory *certificates*, from the governor, or commander in chief, of the place of growth, with an *account* of the number of trees, their age, nearly the quantity of fruit on each tree, and the manner of culture, to be produced on or before the first Tuesday in December, 1802.

150. CLOVES. For importing into the port of London, in the year 1802, the greatest quantity of cloves, not less than twenty pounds weight, being of the growth of some of the islands of the West Indies subject to the crown of Great Britain, or any of the British settlements on the coast of Africa, or the several islands adjacent thereto, and equal in goodness to the cloves brought from the East Indies; the gold medal, or fifty guineas. Samples, not less than two pounds weight, with *certificates* that the whole quantity is equal in goodness, together with satisfactory *certificates* signed by the governor, or commander in chief, of the place of growth, with an *account* of the number of trees growing on the spot, their age, and the manner of culture, to be produced to the Society on or before the first Tuesday in January, 1803.

151. PLANTATIONS OF BREAD-FRUIT-TREES. To the person who shall have raised in any of the islands of the West Indies subject to the crown of Great Britain, or in any of the British settlements on the coast of Africa, or

the several Islands adjacent thereto, between the 1st of January, 1801, and the 1st of January, 1802, the greatest number of bread-fruit-trees, not fewer than one hundred, and properly fenced and secured the same, in order to supply the fruit to the inhabitants; the gold medal, or thirty guineas. Proper *accounts* and *certificates*, signed by the governor, or commander in chief, of the methods made use of in cultivating the plants and securing the plantation, and that the trees are in a growing and thriving state at the time of signing such certificates, to be produced to the Society, with samples of the fruit, on or before the first Tuesday in January, 1803.

152. KALI FOR BARILLA. To the person who shall have cultivated, in the Bahama-Islands, or any other part of his Majesty's dominions in the West Indies, or any of the British settlements on the coast of Africa, or the several islands adjacent thereto, in the year 1801, the greatest quantity of land, not less than two acres, with Spanish kali, fit for the purpose of making barilla; the gold medal, or thirty guineas.

153. For the next greatest quantity, not less than one acre, the silver medal, or fifteen guineas. *Certificates*, signed by the governor, or commander in chief, for the time being, of the quantity of land so cultivated, and of the state of the plants, at the time of signing such certificates, to be delivered to the Society, with samples of the kali, on or before the second Tuesday in January, 1803.

154. The same premium is extended one year farther. *Certificates* to be produced on or before the second Tuesday in January, 1804.

155. DESTROYING THE INSECT COMMONLY CALLED THE BORER. To the person who shall discover to the Society an effectual method of destroying the insect commonly called the borer, which has, of late years, been so destructive to the sugar-canes in the West India islands, the British settlements on the coast of Africa, and the several islands adjacent thereto; the gold medal, or fifty guineas. The discovery to be ascertained by satisfactory *certificates*, under the hand and seal of the governor, or commander-in-chief, for the time being, and of some other respectable persons, inhabitants of the islands, or other place, in which the remedy has been successfully applied; such *certificates* to be delivered to the Society on or before the first Tuesday in January, 1803.

156. CULTIVATION OF HEMP IN UPPER AND LOWER CANADA. To the person who shall sow with hemp the greatest quantity of land in the province of Upper Canada, not less than six arpents (each four-fifths of a statute acre, in the year 1802, and shall at the proper season cause to be plucked the summer hemp (or male hemp bearing no seed) and continue the winter hemp (or female hemp bearing seed) on the ground until the seed is ripe; the gold medal, or one hundred dollars.

157. To the person who shall sow with hemp the next greatest quantity of land in the same province of Upper Canada, not less than five arpents, in the year 1802, in the manner above-mentioned; the silver medal, or eighty dollars.

158. For the next greatest quantity of land, in the same province, and in a similar manner, not less than four arpents; sixty dollars.

159. For the next greatest quantity of land, in the same province, and in a similar manner, not less than three arpents; forty dollars.

160. For the next greatest quantity of land, in the same province, and in a similar manner, not less than one arpent; twenty dollars. *Certificates* of the number of arpents, the method of culture, of the plucking of the hemp, with a general *account* whether sown broad-cast or in drills, the expense, soil, cultivation, and produce to be transmitted to the Society, certified under the hand and seal of the governor or lieutenant-governor, together with 28 lb. of the hemp, and two quarts of the seed, on or before the first Tuesday in November, 1803.

161, 162, 163, 164, 165. The same premiums are extended one year farther. *Certificates*, &c. as before-mentioned, to be transmitted to the Society, on or before the last Tuesday in February, 1804.

166 to 176. Premiums exactly similar in all respects to those held out for the province of Upper Canada, are also offered for the province of Lower Canada, and are extended to the same period.

177. IMPORTATION OF HEMP FROM CANADA. To the master of that vessel, which shall bring to this country the greatest quantity of marketable hemp, not less than one hundred tons, in the year 1803, the produce of Upper or Lower Canada; the gold medal.

178. To the master of that vessel which shall bring the next quantity, not less than fifty tons; the silver medal. *Certificates* satisfactory to the Society to be produced by the master of the vessel on or before the first Tuesday in February, 1804, to testify that such hemp was grown and prepared in Canada.

PREMIUMS OFFERED FOR THE ADVANTAGE OF THE BRITISH SETTLEMENTS IN THE EAST INDIES.

179. BHAUGULPORE-COTTON. To the person who shall import into the port of London, in the year 1802, the greatest quantity, not less than one ton, of the Bhaugulpore-cotton, from which clothes are made in imitation of nankeen, without dying; the gold medal. A quantity of the cotton, not less than five pounds weight in the pod, and five pounds carded, to be produced to the Society, with proper *certi-*

ficates, signed by the secretary to the board of trade of Bengal or Bombay, on or before the last Tuesday in February, 1803.

180. ANNATTO. To the person who, in the year 1802, shall import into the port of London, from any part of the British settlements in the East Indies, the greatest quantity of annatto, not less than five hundred weight; the gold medal. A quantity of the annatto, not less than ten pounds weight, to be produced to the Society, with proper *certificates*, signed by the secretary of the board of trade of the respective settlement, that the annatto is the produce of such settlement, on or before the last Tuesday in February, 1803.

181. TRUE COCHINEAL. To the person who, in the year 1802, shall import into the port of London, from any part of the British settlements in the East Indies, the greatest quantity of true cochineal, not less than five hundred weight; the gold medal. A quantity of the cochineal, not less than ten pounds weight, with proper *certificates*, signed by the secretary of the board of trade of the respective settlement, that the cochineal is the produce of such settlement, to be produced to the Society on or before the first Tuesday in February, 1803.

CONDITIONS FOR THE POLITE ARTS.

No person who has gained the first premium in any class shall be admitted a candidate in a class of an inferior age; and no candidate shall receive more than one premium in one year; nor shall they, who for two successive years have gained the first premium in one class, be again admitted as candidates in that class.

No person shall be admitted a candidate in any class, who has three times obtained the first premium in that class.

No more than one performance in any class shall be received from the same candidate.

All performances (to which premiums or bounties are adjudged) shall remain with the Society till after the public distribution of rewards in May, when they will be re-delivered unless mentioned in the premiums to the contrary.

No performance shall be admitted, that has obtained a premium, reward, or gratification, from any other society, academy, or school, or been offered for that purpose.

All performances that obtain premiums in the Polite Arts must have been begun after the publication of such premiums, except line engravings.

To encourage real merit, and prevent attempts to impose on the Society, by producing drawings made or retouched by any other person than the candidate, the Society require a specimen of the abilities of each successful candidate in classes 97 to 122 inclusive, under the inspection of the Committee of Polite Arts, in every instance where such proof may appear necessary.

All candidates in the Polite Arts are required to signify, on their drawings, their age; and whether the performances are originals or copies; and if copies, whence they were taken.

SOCIETY'S OFFICE, ADELPHI, JUNE 1st, 1802.

ORDERED,

That the several Candidates and Claimants to whom the Society shall adjudge Premiums or Bounties, do attend at the Society's Office in the Adelphi, on the last Tuesday in May 1803, at Twelve o'Clock at Noon precisely, to receive the same; that Day being appointed by the Society for the Distribution of their Rewards: And before that Time no Premium or Bounty will be delivered, excepting to those who are about to leave the kingdom.

In Cases where the Society may think fit to admit Excuses for not attending in Person, Deputies may be substituted to receive the Rewards, provided such Deputies are either Members of the Society, or the superior Officers thereof.

GENERAL CONDITIONS.

As the great object of the Society in rewarding individuals is to draw forth and give currency to those inventions and improvements, which are likely to benefit the public at large, candidates are requested to observe, that if the *means*, by which the respective objects are effected, do require an expense or trouble too great for *general purposes*, the Society will not consider itself as bound to give the offered *reward*; but, though it thus reserves the power of giving in all cases such part only of any premium as the performance shall be adjudged to deserve, or of withholding the whole if there be no merit, yet the candidates may be assured the Society will always judge liberally of their several claims.

It is required that the matters for which premiums are offered, be delivered in without names or any intimation to whom they belong; that each particular thing be marked in what manner

each claimant thinks fit, such claimant sending with it a paper sealed up, having on the outside a corresponding mark, and, on the inside, the claimant's name and address; and all candidates are to take notice, that no claim for a premium will be attended to, unless the conditions of the advertisement are fully complied with.

No papers shall be opened, but such as shall gain premiums, unless where it appears to the Society absolutely necessary for the determination of the claim; all the rest shall be returned unopened with the matters to which they belong, if inquired after by the mark, within two years; after which time, if not demanded, they shall be publicly burnt, unopened, at some meeting of the Society.

All models of machines, which obtain premiums or bounties, shall be the property of the Society; and, where a premium or bounty is given for any machine, a perfect model thereof shall be given to the Society.

All the premiums of this Society are designed for Great Britain and Ireland, unless expressly mentioned to the contrary.

The claims shall be determined as soon as possible after the delivery of the specimens.

No person shall receive any premium, bounty, or encouragement, from the Society, for any matter for which he has obtained, or purposes to obtain, a patent.

A candidate for a premium, or a person applying for a bounty, being detected in any disingenuous method to impose on the Society, shall forfeit such bounty, and be deemed incapable of obtaining any for the future.

The performances which each year obtain premiums or bounties are to remain with the Society until after the public distribution of rewards.

No member of this Society shall be a candidate for, or entitled to receive, any premium, bounty, or reward, whatsoever, except the honorary medal of the Society. The candidates are, in all cases, expected to furnish a particular account of the subject of their claims; and, where certificates are required to be produced in claim of premiums, they should be expressed, as nearly as possible, in the words of the respective advertisements, and be signed by persons who have a positive knowledge of the facts stated.

Where premiums or bounties are obtained in consequence of specimens produced, the Society mean to retain such part of those specimens as they may judge necessary, making a reasonable allowance for the same.

No candidates shall be present at any meetings of the Society or committees, or admitted at the Society's rooms, after they have delivered in their claims, until such claims are adjudged, unless summoned by the committee.

N. B. The Society farther invite the communications of scientific and practical men upon any of the subjects for which premiums are offered, although their experiments may have been conducted upon a smaller scale than the terms of each require, as they may afford ground for more extensive application, and thus materially forward the views of the Society and contribute to the advantage of the public. Such communications to be made by letter, addressed to the Society, and directed to Mr. CHARLES TAYLOR, the Secretary, *at the Society's Office, in the Adelphi, London.*

The models required by the Society should be upon the scale of one inch to a foot. The Winchester bushel is the measure referred to for grain; and, as the acres of different districts vary in extent, it is necessary to observe, that the Society mean Statute Acres, of five and a half yards to the rod or pole, when acres are mentioned in their list of premiums; and they request that all communications to them may be made agreeably thereto.

The Society desire that the Papers on different subjects sent to them may be full, clear, explicit, fit for publication, and rather in the form of Essays than of Letters.

*** To persons inclined to leave a sum of money to this Society by will, the following form is offered for that purpose:

Item. I give and bequeath to A. B. and C. D. the sum of upon condition and the intent that they, or one of them, do pay the same to the collector for the time being, of a Society in London, who now call themselves the Society for the Encouragement of Arts, Manufactures, and Commerce; which said sum of I will and desire may be paid out of my personal estate, and applied towards the carrying on the laudable designs of the Society.

By Order of the Society,

CHARLES TAYLOR, *Secretary.*

Society of Arts Manufactures and Commerce,

ADELPHI, *June 21st*, 1802.

ON Wednesday, the 2d Inst. the Society held the last Meeting of that Session, and adjourned to the fourth Wednesday in October next.

On Tuesday the 25th of May last, agreeably to the Resolutions of the Society, the Premiums and Bounties which had been then adjudged during the Session, were delivered to the Claimants from the Chair, by his Grace the Duke of Norfolk, the President, in presence of a very numerous and respectable Assembly. The Business was begun by an appropriate Speech from the Secretary, noticing the Objects of the Society from its Institution, in the year 1754, to the present Time, and particularising the Rewards which had been then adjudged this Session.

The Rewards awarded, are arranged under the following Classes:

IN AGRICULTURE.

To John Hunter, esq. of Gubbins, in Hertfordshire, for having planted 40,000 Oaks, the Gold Medal.

To Thomas Johnes, esq. of Hafod, in Cardiganshire, for having planted 400,000 Forest Trees, the Gold Medal.

To John Christian Curwen, esq. of Workington Hall, in Cumberland, for having planted 84,900 Larch Trees, the Gold Medal.

To Henry Vernon, esq. of Hilton Park, near Wolverhampton, for planting 10,000 Silver Firs, the Gold Medal.

To James Beech, esq. of Shaw, near Cheadle, in Staffordshire, for his plantation of Timber Trees, the Silver Medal.

To the Rev. Richard Yates, of Chelsea, for his Essay on raising and promoting the growth of Oaks, the Silver Medal.

To Charles Gibson, esq. of Quermore Park, near Lancaster, for planting 6,000 Elms, the Silver Medal.

To William Fairman, esq. of Miller's House, near Sittingbourn, in Kent, for his Experiments on Extreme Branch Grafting of Fruit Trees, the Silver Medal.

To Robert Brown, esq. of Markle, near Haddington, in Scotland, for his Culture of Beans and Wheat in one year on the same Land, the Silver Medal.

To Mr. Frederic Clifford Cherry, of New Wood Farm, near Stoke d'Aubenton, in Surry, for planting 60 Acres with Osiers, the Sum of Thirty Guineas.

To Mr. Seth Bull, of Ely, in Cambridgeshire, for planting 8 Acres with Osiers, the Sum of Ten Guineas.

IN CHEMISTRY.

To Mr. Thomas Willis, of Lime Street, London, for his preparation of the Bulbs of the Hyacinthus non scriptus, or common Field Blue Bells, as a substitute for Gum Arabic, the Silver Medal.

IN POLITE ARTS.

To George William Gent, esq. of Upper Guildford Street, for a Drawing of Lewes Castle, in Essex, the Gold Medal. Cl. 89.

To Miss Elizabeth Mac Dowall, of Brook Street, Holborn, for a Chalk Drawing of the Virgin and Child, the Gold Medal. Cl. 91.

To Miss Winifred Barrett, of Stockwell, in Surry, for a Drawing of a Landscape, the Silver Medal. Cl. 91*.

To Miss Jackson, of Hanover Street, Hanover Square, for a Drawing in Black Chalk, after an Engraving by Bartolozzi, the Silver Medal.

To Miss Blackburne, of Park Street, Westminster, for a Drawing of Demosthenes from a Bust, the Silver Medal.

To Miss Mary Anne Gilbert, of Devonshire Street, Portland Place, for a Miniature Drawing of an old Woman, after Nature, the Silver Medal.

To Miss Emma Farhill, of Mortimer Street, Cavendish Square, for a Drawing of Peasants in a Storm, the Silver Medal.

To William Stone Lewis, esq. of High Holborn, for a Drawing of Outlines of the Laocoon, from a Cast, the larger Silver Pallet. Cl. 92.

To George Jones, esq. of Great Portland Street, Mary-le-bone, for a Drawing of Outlines of Hercules and Antæus, from a Cast, the lesser Silver Pallet. Cl. 93.

To Richard Speare, esq. of Dean Street, Soho, for a Drawing, a View at Eltham, in Kent, the greater Silver Pallet. Cl. 94.

To Mr. Richard Cook, of Upper Charlotte Street, Fitzroy Square, for a Drawing of Mutius Scævola, before Porsenna, the Gold Pallet. Cl. 96.

To Mr. John Summerfield, of Packington, Coventry, for a Stroke Engraving, the subject Rubens and his Wife, the Gold Medal. Cl. 98.

To Mr. C. Nesbitt, of Fetter Lane, for Engravings on Wood, the Silver Medal. Cl. 103.

To Mr. Richard Austin, of Paul's Alley, Barbican, for Engravings on Wood, the Silver Medal.

To Mrs. Elizabeth Coppins, of St. Stephen's, Norwich, for a Drawing in Crayons of Belisarius, copied from a Painting of Salvator Rosa, the greater Silver Pallet.

To Miss Frances Talbot, of Wymondham, Norfolk, for a Painting of an Herb Girl, from Nature, the Silver Medal.

To Miss Beauchamp, of Langley Park, near Beccles, in Suffolk, for a Painting of a Landscape, copied from Both, the Silver Medal.

To Dr. John Evans, of Shrewsbury, for two Maps of North Wales, the Sum of Forty-five Guineas.

IN MANUFACTURES.

To Mr. Thomas Clulow, of Shoreditch, for his Invention of weaving Purses, Pockets, and Sacks, in a Loom, and improving the Construction of Looms in general, Twenty-five Guineas.

IN MECHANICS.

To Mr. Henry Greathead, of South Shields, in the Bishoprick of Durham, for his Construction of a Cork Boat, by which the Lives of many Persons shipwrecked have been preserved, the Gold Medal and Fifty Guineas.

To William Hall Timbrel, esq. of Streatly, in the County of Berks, for an improved herniary Truss and new invented Calico Cushion, the Gold Medal.

To Mr. Richard Knight, of Foster Lane, Cheapside, for his Method of clearing Land from Stumps of Trees, and rendering them in a proper State for Fuel, the Silver Medal.

To Mr. James Brownhill, of Alloa Mills, near Stirling, in Scotland, for his Discovery of a Quarry of Stone, proper for making Mill Stones, the Sum of One Hundred Pounds.

To Mr. John Webb, of Dorrington Street, for an Invention in Gun Locks, to prevent accidents in using Guns or Pistols, and to guard against their being improperly fired, the Sum of Twenty Guineas.

To Mr. James Woart, of Fulham, for securing Beams of Timber decayed by Time, or injured by Accidents, in Buildings, the Sum of Ten Guineas.

IN COLONIES AND TRADE.

To Dr. Alexander Anderson, of St. Vincent, for the Culture of Cloves and Cinnamon, the Gold Medal.

To the Hon. Joseph Robley, of Tobago, for a Plantation of Bread Fruit Trees, the Gold Medal.

An Account of the Number of Noblemen and Gentlemen elected Members since October last, whose Titles and Names are as follow:

The Most Noble the Marquis of Exeter, F. R. S. and S. A. the Right Hon. Lord Viscount Barrington, the Right Hon. Lord Carrington, Sir Geo. Prescot, Bart. Hon. John Henniker Major, John Robinson, esq. M. P. Col. Peachy, M. P. Rowland Burdon, esq. M. P. Lieut. Gen. John Watson, James Brogden, esq M. P. Mr. Sheriff William Rawlins, Thomas Myers, esq. Joseph Nollekins, esq. R. A. John Dixon, esq. George Prescott, esq. Thomas Calverly, esq. Thomas Taylor, esq. Mr. John Sowerby, John Scott, esq. William Gosling, esq. Alexander Scott, esq. Mr. William Woodburn, Mr. Vaughan Griffiths, Charles Tufton Blicke, esq. Mr. John Francis Desanges, William Irving, esq. Lieut. Col. Francis John Wilder, James Anderson, esq. LL. D. Daniel Moore, esq. Solomon Levien, esq. W. H. Pepys, jun. James Green, esq. Mr. John Fuller, David Pike Watts, esq. William Bridgman, esq. William Phillips, esq. Richard Sykes, esq. Mr. John Dutton, Henry Leader, esq. Rev. Mr. J. Clay, Josiah Robert Harrison, esq. John Gold, esq. Richard Varal, esq. Richard Godwin, esq. Thomas Edwards, esq. William Butler, esq. Mr. William Peter Whyte, Mr. Thomas Bish, Henry Decort, esq. Valentine Green, esq. Martin Bree, esq. James Kendrick, esq. Henry Gore Clough, esq. Mr. William Woodthorp, Charles Winstanley, esq. Joseph Ablett, esq. Dr. Clough, William Tooke, esq. William Coles, esq. Mr. William March, Mr. William Chapman, Joseph Williams, esq. Samuel Lovat, esq. Walter Bracebridge, esq. Henry Winstanley, jun. esq. Daniel Llewellin, esq. John M'Arthur, esq. William Minnitt, esq. Mr. Thomas Jones, David Forbes, esq. Joseph Martin, esq. William Lechmer, esq. Ambrose Pitman, esq. Mr. George Samuel, Col. William Tatham, J. S. Munnings, esq. Mr. Edward Vennor, George Lockett, esq. William Green, esq. Christopher Fowler, esq. Mr. Samuel John Neal, William Nethersole, esq. William Pierrie, esq. George Banastre Pix, esq. John Hunter, esq. Mr. Alexander Sheafe Birkett, Mr. Joseph Bunnell, Mr. William Marston, Mr. James Little, Stephen Scarbrow, esq. Col. William Gent, Dr. Ogilvie, William Breton, esq. Thomas Cartwright Slack, esq. John Watkin Phipps, esq. Mr. Thomas Courtney Devenish, Mr. William Bennett, Major Henry Eustace, William James, esq. Thomas Poynder, jun. esq. Henry Michele, esq. Samuel Gunnel, esq. Drewhurst Bilsborow, esq. Rev. William Phillips, Thomas Leys, esq. James St. Aubyn, esq. William Henry Cheek, esq. Thomas Stackhouse, esq. George Clark, esq. Philip Neill, esq. William Wills, esq. John Maud, esq. Thomas Windus, esq. Lewis Buckle, esq. Ralph Dodd, esq. Mr. Thomas Wilson, Charles Browning, esq. Mr. Henry Greathead, Mr. Richard Reeve, John Rowe, esq. Thomas Andrews, esq. Mr. Gilson Reeve, Edward Biven, esq. John Barnwell Murphy, esq. Peter Green, Esq. John Abearn Palmer, esq. John Flamank, esq. Joseph Ivatt Harwood, esq. Mr. William Gedge, John Jones, esq. Robert Bevil, esq. Mr. John Fletcher, Robert Blake, esq. Capt. H. L. Frezill, Mr. Joseph Cooper, Benjamin Hall, esq. Cuthbert Sharp, esq. Robert Drury, esq. Captain F. M. Keith, Mr. George Arnoldi.

By Order,

CHARLES TAYLOR, Secretary.

XX. *An Attempt towards a Theory of the Reſiſtance experienced by two and four-wheeled Carriages on different Kinds of Roads; and to determine the Circumſtances under which the one are preferable to the other.* By NICHOLAS FUSS, *Profeſſor of the higher Mathematics at Peterſburgh, Member of the Imperial Academy of Sciences, &c.**

THE following paper was written in anſwer to a queſtion propoſed as the ſubject of a prize for the year 1797 by the Royal Academy of Sciences at Copenhagen, and obtained the firſt prize. To avoid confuſion or miſtake, we have adopted the author's notation, and have adhered as cloſely to the original as the nature of the ſubject would admit.—E.

Section 1.

The queſtion, which I firſt ſaw in the 113th number of the Göttingen *Gelehrten Anzeigen* for the year 1796, was in the following words:—*Ex principiis mechanicis exponere rationem potentiæ motricis ad onera, tum planiſtris quatuor rotarum, tum carris, qui ſunt binarum rotarum, promovenda; ita quidem, ut ad impedimenta motus, frictionem ſcilicet, ac reliqua quæ in viis occurrere ſolent, obſtacula à vi motrice ſuperanda ſimul reſpiciatur. Quo in univerſum pateat, num et quando hoc illudve genus vehiculi commode et prudenter adhiberi poſſit.* That is: "To determine, from mechanical principles, the ratio of the moving power to the burthen both in four-wheeled and two-wheeled carriages, taking into account at the ſame time the impediments to motion, that is to ſay, friction, and the other obſtacles to be overcome by the moving power which commonly occur in roads, that it may in general appear on what occaſions either of theſe carriages can be employed with moſt advantage."

The general utility of this queſtion induced me, laſt ſummer, to employ the leiſure I then enjoyed in the country, in conſequence of two months relaxation from my uſual occupations, in examining it, with a view of ſubmitting my labour to the inſpection of the enlightened ſociety who propoſed it; and I ſhall be happy if the learned and celebrated men to whom the ſociety have entruſted the power of adjudging the prize, ſhould find in the following reſearches any thing to indemnify them for their trouble.

* From *Verſuche einer Theorie des Widerſtandes zweyund vierrädriger Fuhrwerke, auf Fahrwegen jeder art, &c.* Von Nicolaus Fuſs, &c. Copenhagen 1798.

Section 2.

The roads and ways on which loaded carriages are drawn from one place to another by horſes, oxen, and other animals, are ſo different in their nature, and the impediments which the moving power has to overcome are ſo numerous, that, on the firſt view, it appears very difficult to find general formulæ to indicate the reſiſtance for every given kind of road, carriage and loading, and to determine the circumſtances under which the one kind of carriage is to be preferred to the other. However, when we ſeparate from conſtant impediments the action of which is nearly uniform, and which, properly ſpeaking, characterize the nature of the way, but without excluding them from our reſearch, thoſe which occur on every road, but only occaſionally, and which, conſequently, can be overcome by a momentary exertion of the moving power, among which may be included ſingle eminences and hollows, ſuch as ridges, ſtones, channels, holes, pavements, bridges, &c.; all the different kinds of roads may be reduced to the three following claſſes:

1ſt, Solid and ſmooth, to which belong all level as well as inclined roads, crooked and ſtraight; alſo hollow roads, with ſolid, broad, ſmooth ruts: in a word, all roads the ſurface of which is neither rugged nor yields to the impreſſion of the wheels.

2d, Solid and uneven, which do not ſuffer the wheels to ſink into them, but which, by their inequality, preſent a pretty uniform reſiſtance. In this claſs are comprehended rough rugged roads, interſperſed with ridges of rock, paved roads, and roads in which parts are covered with timber and the trunks of trees.

3d, Soft ſmooth roads which yield to the impreſſion of the wheels, ſuch as marſhy or clayey roads, or roads covered with ſoft earth, ſand, flints, or ſmall ſtones.

Section 3.

As all roads, either in whole or in part, are comprehended in one of the above claſſes, I ſhall examine them according to theſe principal diviſions, and determine for each in particular the reſiſtance experienced by four as well as by two-wheeled carriages, and point out the conditions under which the one kind of carriage is to be preferred to the other for each kind of road. It appears, however, that a diſtinction ought to be made in regard to each of theſe three claſſes; that is to ſay, whether the road be horizontal or inclined, ſmooth or covered with ſmall eminences, new or worn into

circular inequalities. But, as level as well as inclined roads covered with ſmall eminences and interſected with circular depreſſions, as far as the comparative maximum of reſiſtance is concerned, belong to inclined roads, and may be conſidered as ſuch with an increaſed degree of inclination, the angle of inclination may be taken into the calculation without much difficulty; conſequently theſe properties require no particular diviſion.

Section 4.

But, though this natural diviſion of all the different kinds of roads into three principal claſſes will facilitate a compariſon between two-wheeled and four-wheeled carriages in regard to the reſiſtance which they oppoſe to the moving power on each kind of road propoſed, which is properly the object of this reſearch; it, on the other hand, appears difficult to give a ſatisfactory anſwer to the firſt part of the queſtion, and to deduce, from mechanical principles, the ratio of the moving power to the reſiſtance. The latter, indeed, can be determined *à priori* from ſtatical principles; but this is not the caſe with the former, which, on account of the endleſs difference in the ſtrength of animals, and the various modifications of this ſtrength on different roads, can be determined only by experiments, and even then the reſult will be merely an approximation.

Section 5.

In the following determinations, however, that I may be able in ſome meaſure to compare each kind of reſiſtance with the moving power, I ſhall premiſe the following principles:

1ſt, That the weight M, equal to one pound, (Plate II. fig. 1.) freely ſuſpended from a rope paſſing over the fixed pulley C, is the heavieſt that an animal ſtanding on the level plain AB can draw or ſuſtain during the period of t hours.

2d, That G is the greateſt velocity with which the above animal, without bearing any burthen or drawing any thing after it, can travel for the period of t hours along a road of any given nature; ſo that, in regard to this animal, the velocity G will be ſometimes greater and ſometimes leſs, according to the nature of the road.

Now, if M and G, in regard to the animal which we ſuppoſe to be employed, and in regard to the road on which the burthen is to be carried, be known by experiments, we ſhall have a determinate meaſure of the moving power, as we know that the propoſed animal can draw on the propoſed road during the period of t hours, with the velocity g, a freely

suspended weight of $M\left(1-\frac{g}{G}\right)^2$ pounds. This well known formula, however, is only empirical; but it agrees so far with experience as to answer all the purposes of practice.

Section 6.

Now if the resistance which, in regard to four-wheeled carriages we shall express by R, and for two-wheeled carriages by R′, has been found for both these kinds, we shall have,

$$M\left(1-\frac{g}{G}\right)^2 = R; \text{ and } M\left(1-\frac{g'}{G}\right)^2 = R';$$

from which we deduce the velocity with which each of these kinds of carriages is moved, namely,

$$\text{For the four-wheeled } g = G\left(1-\sqrt{\frac{R}{M}}\right);$$

$$\text{For the two-wheeled } g' = G\left(1-\sqrt{\frac{R'}{M}}\right).$$

Having thus established the means for estimating the moving power, I shall now proceed to determine the resistance itself in regard to the different kinds of carriages.

I. DIVISION.

Of the Resistance on solid and smooth Roads.

I. *Four-wheeled Carriages.*

Section 7.

If the road AB (fig. 2.), the inclination of which is the angle $ABC = \alpha$, be perfectly solid and smooth, the resistance to be overcome by the moving power OV will consist of two parts. The first arises from the friction of the wheels against the axle-tree. If the whole burthen resting on the fore and hind axle-trees be $= P$, that supported by each will be $\frac{1}{2}P$; consequently, when the vertical lines OQ and OF, proceeding from O the centre of the axis, the former of which intersects the circumference of the axis in D, and the latter in E, are drawn in the perpendicular direction BA, the pressure on the nave of the wheel in D is $= \frac{1}{2}P$, and in E $= \frac{1}{2}P\cos.\alpha$; consequently, the friction, which acts in the direction $EA = \frac{1}{2}\lambda P\cos.\alpha$, where, as is well known, λ represents a fraction, the quantity of which depends on the matter of the axle-tree and the nave, and on the substance with which they are besmeared. Now for the fore-wheels let $OE = m.OF$, and for the hind-wheels $OE = n.OF$. The resistance in

in the direction FA is for the former $= \frac{1}{2} m \lambda P \cos. \alpha$, and for the latter $= \frac{1}{2} n \lambda P \cos. \alpha$. Hence the whole firſt part of the reſiſtance ariſing from the friction of the axle-tree will be $= \frac{1}{2} (m + n) \lambda P \cos. \alpha$.

Section 8.

The ſecond part of the reſiſtance ariſes from the power of gravity acting in the direction OQ. If the weight of the two fore-wheels be p, and that of the hind-wheels p', the power in the direction OQ is for the fore-wheels $\frac{1}{2} P + p$, and for the hind-wheels $\frac{1}{2} P + p'$; but, in the direction OP, directly oppoſite to the power OV, it is for the former $(\frac{1}{2} P + p) \sin. \alpha$, and for the latter $\frac{1}{2} P + p') \sin. \alpha$. Conſequently, the ſecond part of the reſiſtance $= (P + p + p') \sin. \alpha$.

Section 9.

The power $OV = M \left(1 - \frac{g}{G}\right)^2$, therefore, on roads of this claſs, and in regard to four-wheeled carriages, has to overcome a reſiſtance which is compounded of both theſe parts, ſection 7 and ſection 8:

$$R = \frac{1}{2} (m + n) \lambda P \cos. \alpha + (P + p + p') \sin. \alpha.$$

II. *Two wheeled Carriages.*

Section 10.

In regard to theſe carriages OE (fig. 3.) $= \mu.OF$, and if the weight of the two wheels be $= \pi$, it will be found in the ſame manner as before, ſection 7. and ſection 8. that the reſiſtance from the friction of the axle-tree is $= \mu \lambda P \cos. \alpha$, and that from the power of gravity $= (P + \pi) \sin. \alpha$.

Section 11.

But in this caſe, a third part is to be taken into conſideration. When we aſſume the centre of gravity of the load P in the point S of the line FO continued, and draw through S the vertical line SH, as a weight P preſſes on the ſupporting lever IH in the point H, the horſe at I muſt employ a power IK, which ſhall counteract that power SH = P. This power $IK = \frac{P.OH}{OI}$. Now if OH = OS tang. $\alpha = \varepsilon.OI$, the power, according to the direction IK, will be $= \varepsilon P$; and hence there ariſes in the direction IL a power $\varepsilon P \sin. \alpha$.

Section 12.

Conſequently, the power $OV = M \left(1 - \frac{g'}{G}\right)^2$ on roads

of this class, and in regard to two-wheeled carriages, has to overcome a resistance compounded of these three parts:

$$R' = \mu \lambda P \cos. \alpha + (P + \varepsilon + \pi) \sin. \alpha.$$

III. *Comparison between these two Kinds of Carriages.*

If $\alpha = 0$, then is $R = \frac{1}{2}(m + n) \lambda P$, and $R' = \mu \lambda P$; consequently, $R \lessdot R'$ when $m + n \lessdot 2\mu$. That is: on solid, smooth, horizontal roads, four-wheeled carriages are better than two-wheeled when the axles and wheels are so constructed that the sum of the exponents of the ratio of their diameters in the former, is less than double the exponent of the ratio of the diameters of the axles and wheels in the latter.

Section 14.

If $p + p' = \varepsilon P + \pi$, then will $R \lessdot R'$, when $\mu + n \lessdot 2\mu$. That is: on solid, smooth, inclined roads, four-wheeled carriages are to be preferred to two-wheeled carriages under the above conditions, provided also that the weight of the fore and hind wheels in the former is equal to the sum of the weight of the wheels and of the overweight * in the latter.

Section 15.

If $m + n = 2\mu$, then is $R \lessdot R'$, when $p + p' \lessdot \varepsilon P + \pi$. That is: on solid, smooth, inclined roads, four-wheeled carriages are preferable to two-wheeled carriages when the ratio of the diameters of the axles and wheels is such that the sum of the exponents in the former is equal to double the exponents in the latter, and provided also that the weight of the wheels of the four-wheeled carriage is less than the weight of the wheels and the overweight in the two wheeled carriages.

Section 16.

From the comparison, in general it results, that for this kind of roads four-wheeled carriages ought to be preferred to two-wheeled carriages.

1st, When in regard to the proportion between the wheels and the axle-trees,

$$\frac{m + n - 2\mu}{2} \lessdot \frac{(\varepsilon P + \pi - p - p') \text{ tang. } \alpha}{\lambda P}.$$

2d, When in regard to the weight of the wheels,

$$p + p' - \pi \lessdot \varepsilon P - \frac{(m + n - 2\mu) \frac{1}{2} \lambda P}{\text{tang. } \alpha}.$$

3d, When in regard to the weight of the load,

$$P \gtrdot \frac{(p + p' - \pi) \text{ tang. } \alpha}{\varepsilon \text{ tang. } \alpha - \frac{1}{2} \lambda (m + n - 2\mu)}.$$

* That which arises from the centre of gravity being thrown behind the axle. See section 11, and also fig. 3.

4th,

4th, When in regard to the height of the load or of the centre of gravity,

$$\varepsilon > \frac{(p + p' - \pi) \text{ tang. } \alpha + \frac{1}{2}\lambda P\,(m + n - 2\mu)}{P \text{ tang. } \alpha}.$$

5th, When in regard to the ſteepneſs of the road,

$$\text{tang. } \alpha > \frac{\frac{1}{2}\lambda P\,(m + n - 2\mu)}{\varepsilon P + \pi - p - p'}.$$

IV. *Application to ſome determinate Caſes.*

A few examples in numbers will illuſtrate the uſe of the expreſſions found both for R and R′, and alſo the compariſon of them with the moving power.

Example I.

Section 17.

Let us ſuppoſe that the road goes up a hill at an angle $\alpha = 10°$. Let the mean diameter of the axles of the four-wheeled carriages be $3\frac{1}{7}$ inches, that of the fore-wheels 28 inches, that of the hind-wheels 42 inches; ſo that $m = \frac{1}{8}$, and $n = \frac{1}{12}$. Let the weight of the fore-wheels be $p = 80$ lib., that of the hind-wheels $p' = 110$ lib. Alſo, let the mean diameter of the axles of the two-wheeled carriages be $4\frac{1}{3}$ inches, the diameter of the wheels 39 inches; ſo that $\mu = \frac{1}{9}$, and the weight of the wheels $\pi = 110$ lib. Let the load of both carriages $P = 2400$ lib., and the coefficient of the friction $\lambda = \frac{1}{5}$. In the laſt place, we ſhall ſuppoſe the height of the centre of gravity OS = 4 feet, and OI = 12 feet; ſo that OH = 0·7053, conſequently $\varepsilon = 0{\cdot}0588$. Hence we have,

$\frac{1}{2}(m + n)\,\lambda P \cos.\ \alpha = 49{\cdot}240$
$(P + p + p')\ \text{ſin. } \alpha = 449{\cdot}750$

$R = 498{\cdot}990$

$\mu\lambda P \cos.\ \alpha = 52{\cdot}523$
$(P + \varepsilon P + \pi)\ \text{ſin. } \alpha = 460{\cdot}352$

$R' = 512{\cdot}875$

In this caſe, then, $R \prec R'$, about 13·885 lib.

In regard to the moving power it may be admitted that a good draught horſe can draw, for three hours, in the manner above deſcribed, ſection 5, a burthen of 400 lib.; and that the ſame horſe, unloaded, can travel three hours on the road ſuppoſed in this example with a velocity of 12 feet per ſecond: for two ſuch horſes, then, we ſhall ſuppoſe M =

800 lib., and G = 12 feet. From these values, and R and R′ already found, we therefore have by section 6 the velocities $g = 2{\cdot}520$, and $g' = 2{\cdot}392$ feet in a second; so that these two horses on the given road could draw the load P = 2400 lib., at the rate of 9072 feet in an hour with a four-wheeled carriage, but with a two-wheeled carriage only 8611 feet per hour.

EXAMPLE II.

Section 18.

Let us assume, as before, $m = \frac{1}{8}$, $n = \frac{1}{15}$, $p = 80$, $p = 110$ and $\lambda = \frac{1}{4}$. Let the load in this case be only P = 1400 lib., and the inclination of the road $\alpha = 6°$. Let the weight of the wheels of the two-wheeled carriage be $\pi = 130$ lib., their diameter 48 inches, and the mean diameter of the axles 4 inches; so that $\mu = \frac{1}{12}$. In the last place, let the height of the centre of gravity OS = 2 feet; so that OH = OS tang. α = 0·2102, and consequently $\varepsilon = 0{\cdot}01752$. Hence we shall have

$$\tfrac{1}{2}(m + n)\,\lambda P \cos.\,\alpha = 29{\cdot}007$$
$$(P + p + p')\,\sin.\,\alpha = 166{\cdot}200$$

$$R = 195{\cdot}207$$

$$\mu\lambda P \cos.\,\alpha = 23{\cdot}205$$
$$(P + \varepsilon P + \pi)\,\sin.\,\alpha = 162{\cdot}492$$

$$R' = 185{\cdot}697$$

In this case, therefore, R ≻ R′, about 9·510 lib. For a horse, then, the strength of which is M = 400 lib., and the velocity on the above road G = 14 feet per second, we shall have $g = 4{\cdot}228$ feet, and $g' = 4{\cdot}466$ feet. Consequently, the load P = 1400 lib. would be drawn by such a horse on a four-wheeled carriage 15,220 feet per hour, and on a two-wheeled carriage only 857 feet further.

[To be continued.]

XXI. *On Painting.* *By Mr.* E. Dayes, *Painter.*

To Mr. Tilloch.

DEAR SIR,

THE following essays on Taste, Beauty, Grace, Invention, and Composition, being immediately connected with painting, I have done myself the pleasure of sending them for insertion in your valuable Magazine. I shall be obliged by

by your numbering the eſſays, ſuppoſing that on the Compoſition of Landſcape *, inſerted in your eighth volume, to be No. 1. I do not mean to ſay in point of order it ſhould be ſo, but the incloſed form a regular ſeries as far as they go. I ſhall offer no apology for the frequent quotations introduced; my reaſon for ſo doing being not only to ſtrengthen the argument, but alſo to relieve the reader.

I remain, dear Sir,

Francis-ſtreet, Bedford-ſquare, July 5, 1802. your humble ſervant, EDWARD DAVES.

ESSAY II.

On Taſte.

'Tis taſte, tis genius, 'tis heav'nly ray,
Prometheus raviſh'd from the car of day,

MASON'S FRESNOY.

TASTE in the arts muſt be conſidered as that faculty or thoſe faculties of the mind by which we are affected with, and form a right judgment in, works of the imagination. It is that which determines the painter in his choice, and from that choice we judge whether his taſte be good or the contrary. Whether this faculty of the mind is to be acquired is doubtful; that it may be improved is unqueſtionable; hence it becomes our duty to avoid, particularly in our firſt outſet, if poſſible, the ſeeing, much leſs the copying, things deformed and chimerical, as there is an acquired as well as a natural dulneſs. He whoſe taſte is delicately juſt may be ſaid to have received the higheſt poliſh from nature, and one of her choiceſt gifts; on the contrary, to want it, is to be dead to all the finer feelings. The man who poſſeſſes a juſtly cultivated taſte is let into a thouſand pleaſures unknown to the vulgar,

——————His the city's pomp,
The rural honours his. Whate'er adorns
The princely dome, the column and the arch,
The breathing marbles and the ſculptured gold,
Beyond the proud poſſeſſor's narrow claim,
His tuneful breaſt enjoys. AKENSIDE.

On the contrary, there are ſome men born with feelings ſo

* From the favourable reception the eſſay here alluded to experienced, having been tranſlated into ſeveral of the moſt reſpectable of the foreign journals, we have no heſitation in promiſing, that the lovers of the fine arts in general, and practical artiſts in particular, will derive much inſtruction and information from the eſſays with which Mr. Daves has now favoured us. On the fine arts we have had too many publications from mere amateurs, and hardly any from profeſſional men. From the latter, a ſingle practical fact, delivered in a few lines, muſt always be of more intrinſic value than whole volumes from the former.—EDIT.

blunt

blunt and cold that they can hardly be ſaid to be awake during life. From a degree of exquiſite ſenſibility ariſe our notions of beauty and deformity in the natural as well as the moral world, and as our different minds happen to be more or leſs exquiſite, the more or leſs ſenſibly do we perceive the various degrees of good and bad, and of courſe, are more or leſs capable of being charmed with the right and beautiful, and diſguſted with the wrong and deformed. Hence it is that this ſenſibility conſtitutes what is termed genius, which is only the power or capacity of clearly conceiving and properly combining images, and of adding to mere theory practice: to which a ſound head and a good heart is as neceſſary as a delicate imagination; for we cannot poſſeſs true genius without as exquiſite a feeling for moral beauty as for what is great and beautiful in nature or maſterly in poetry, painting, ſculpture, and muſic.

The reverſe of true taſte is ſhown in magnificence, parade, and luxury; and in whatever is horribly glaring, extravagant, and unnatural in the laſt degree. Gold, ſhowy colours, gaudy tapeſtry, the heavy, clumſy, and whatever is ſuperfluous, will ever paſs with the vulgar for elegance and greatneſs. So perſons of a bad taſte will prefer the forced, unnatural, and exaggerated, in expreſſion, attitude, or colour, to the truly ſimple, noble, or beautiful. We ſhould be guilty of an error were we to attempt to eſtabliſh one principle of taſte only, for were we to eſtabliſh one as right, all the others muſt be wrong; hence the miſtake of Sir Joſhua Reynolds, in ſpeaking of the Hercules, Gladiator, and Apollo; for, though each of thoſe figures are perfect of their kind, yet Sir Joſhua affirms that the higheſt perfection of the human figure is not to be found in any one of them, "but in that form which is taken from them all, and which partakes equally of the activity of the Gladiator, of the delicacy of the Apollo, and of the muſcular ſtrength of the Hercules." Such an opinion is contrary to nature, as it goes to deſtroy that variety ariſing from the active, the delicate, and the ſtrong: as well might we ſuppoſe a fine tree from conſolidating the various forms found in nature.

We muſt carefully diſtinguiſh between truth and taſte; for a thing may be true, and not poſſeſs one atom of taſte. The Dutch and Flemiſh pictures are true, as far as mere imitation goes; but will any one ſay, the wretches one ſees in ſome of Rembrant's works are taſty, or can the women of Rubens be conſidered as ſuch; yet thoſe men poſſeſſed great taſte in colour, *chiaro-ſcuro*, &c. We ſhould be careful of miſtaking tinſel for gold; many who repreſent kings, do it by a great

diſplay

diſplay of ornaments, elſe make them ſtrut and ſtare, or have recourſe to a crown; where the greateſt profuſion of ornaments are admiſſible, we ſhould be ſparing in their uſe, for fear of making that fine we cannot make good. Taſte and genius have been called inſpiration, the gift of heaven, and our feelings have been irritated by mere words, that have alarmed and benumbed our faculties; but let us attend to the progreſs of our own minds, and we ſhall find that our taſte has improved in proportion to our induſtry to acquire knowledge. The old maſters have, in their turn, been held up as bugbears to frighten young artiſts; the Italian writers on the arts have on all occaſions uſed the words *heavenly* and *divine*, till they have operated as ſcarecrows, to create a terror in modern painters, many of whom have ceaſed to labour as competitors. We ſhould never ſuppoſe the moſt ſublime degree of perfection has been attained; the fact is, the moſt perfect works are not without their imperfections, and, while that is the caſe, there is room to improve it. M. Angelo is charged with heavineſs; Raphael as being dry, and poſſeſſing a poor *chiaro-ſcuro*; Titian, as defective in drawing; and Parmegiano as making his figures too tall: but, while thoſe conſiderations act as a ſpur to our induſtry, we are bound to venerate them for the great catalogue of perfections they have made us heirs to. It is from theſe they have obtained their renown, the imperfections being only foils. We ſhould never forget the obligations we are under to thoſe who have, by directing our ſtudies, introduced us to the arts; to our parents we owe our being, but to our teachers we owe the power of making a right uſe of it, a matter of no ſmall conſequence.

Taſte is not an imaginary ſomething, depending on the accident of birth, but ariſes from, and is immediately connected with, a ſound judgment. Were there not in art, as in every thing elſe, a ſtandard of right and wrong, all opinion muſt be capricious; but to acquire juſt notions we muſt habituate ourſelves to compare and digeſt our thoughts, be well read in human nature as connected with the characters, manners, paſſions, and affections of man; this, with ſome knowledge of the human mind, will, in time, enable us to diſtinguiſh right from wrong, which conſtitutes the true principles of taſte. We muſt diſtinguiſh real from apparent truth in our purſuit. Real truth does not depend on opinion, it is immutable, fixed, and permanent, and in it muſt be ſought whatever is grand and beautiful. Apparent truth depends on faſhion, and, like it, is fluctuating and uncertain; it may be conſidered as a ſort of impoſtor, for, though it carries with it

it the appearance of ſcience, yet is far from having any true connection with it. Such is the conſtrained air and erect attitude taught in dancing, the violent actions uſed in theatres, and many others not countenanced by nature, but depending wholly on cuſtom for ſupport. The artiſt muſt tread in the ſimple path of nature, and leave thoſe adventitious and forced airs to the perſons to whom they belong, the dancing maſter, hair-dreſſer, &c. Unfortunately there is a faſhion in art, and which the vulgar would attempt to force upon us. Whatever is ſlight, crude, or undetermined, is all the rage, and the artiſts appear to be falling into a habit of painting without form: that deciſion obſervable in the old maſters, and which is inſeparable from the grand ſtyle, is almoſt neglected. To paint for what is termed effect may anſwer the purpoſe of the idle, the ignorant, and thoſe who make a trade of the art, but ſuch a practice will not ſatisfy the diſcerning. The only apology the artiſt can offer is, that he muſt fiſh with ſuch baits as will take: unfortunately, he does not live to paint, but paints to live. The Greeks had a great advantage over the moderns in having philoſophers to judge of their works, and ſtates to reward them.

We muſt not reject works of art becauſe they do not poſſeſs the firſt degree of taſte; for they may be taſty though not ranking in the firſt claſs; juſt as we ſay a thing is ſweet, though it is only in a certain degree ſo. It is the condition of man to labour much to obtain little; this ſhould make us cautious of pronouncing haſtily on works of art: none are unexceptionable, and perhaps there are but few from which we may not derive ſome benefit.

Of the various degrees of taſte, the grand conſiſts in the choice of objects ſuperior to the common (not only in man but in nature), and in the omiſſion of the ſubordinate and trivial parts. Beautiful taſte ſelects the beautiful for imitation. An union of the grand and beautiful will form the beſt and moſt perfect taſte. Meanneſs of taſte expreſſes diſtinctly all the trivial and little parts of objects, hence the whole becomes little. The debaſed or corrupt, delights in things monſtrous, deformed, and ugly: it may be called the *groteſque*, and the praiſe beſtowed on it ſhould be as limited as the views of the artiſt. Thoſe who have ſucceeded moſt in this way, have been praiſed by the ignorant in proportion to the *uglineſs* of the objects introduced in their works. Great and noble ſpirits will ever admire the ſublime parts of creation, while the rural and all the more humble beauties will beſt aſſociate with the domeſtic virtues.

Little

Little minds will ever be employed in the purſuit of trifles, while the elevated ſoul will ſeize mountains in its graſp:

> Who that from Alpine heights his lab'ring eye
> Shoots round the wide horizon to ſurvey
> Nilus or Ganges rolling his bright wave
> Through mountains, plains, through empires black with ſhade,
> And continents of ſand, will turn his gaze
> To mark the windings of a ſcanty rill
> That murmurs at his feet? AKENSIDE.

Wiſdom is the parent of taſte and virtue, the offspring of taſte is pleaſure—of virtue, happineſs. A man without taſte may be ſaid to be without piety, as by not feeling he is incapable of offering that praiſe which reſults from an admiration of the beauties of creation; he has a natural diſreliſh for what is good; he becomes the enemy of all the world; he feels not for a relative, a friend, or ſociety: the law of the land is his goſpel, and his attorney regulates his conſcience; he lives without love, and dies without pity.

We have two ways open to us to acquire a good taſte; the firſt and moſt difficult is by a reference to nature, the ſecond is through the medium of art. But, as the former would prove too difficult a taſk, we muſt therefore firſt diligently apply ourſelves to diſcover it in the works of the moſt celebrated artiſts, and thereby fit ourſelves to purſue the ſame inquiry in nature.

Beſides a perfection of judgment, we have alſo a truth of hand to attain. To this end, having ſelected an object worthy our attention, we are bound to imitate it with all the fidelity we are maſters of; and, as each maſter has in him excellencies not to be found in any other, we muſt avoid a partiality, or we ſhall loſe the benefit to be derived from them all. Thus we ſhall obtain a maſs of information not to be derived from any particular one. Hence the benefit reſulting from viewing galleries of pictures, as the various maſters become correctives to each other, and truth reſults from their general teſtimony. The company and converſation of men *well informed in the arts* will contribute to improve our taſte, becauſe artiſts form opinions on the works of different maſters according to their peculiar manner of thinking, which will naturally furniſh us with hints which we did not attend to, and enable us to enjoy other men's parts and reflections as well as our own. Information from this ſource muſt not, however, be generally expected; the artiſts are not all *wiſe* or *liberal*; many produce an effect without knowing the cauſe, ſome are moroſe and reſerved, others unwilling to

teach another what they have with difficulty learned, and *some few* will be found eafy and communicative.

When we have made ourfelves acquainted with the beauties of art, we may conſider ourſelves at liberty to act on our own foundation; but we are bound to ſhow in our works that we act from an impreſſion made on our minds by nature, or we ſhall never excite ſimilar ſenſations in the ſpectator, but ultimately ſink into mere manneriſts or imitators. A general likeneſs prevailing through the whole of his works muſt ſtamp the artiſt a manneriſt; we mean not, however, ſuch a ſimilitude as may happen by chance. The adoption of a grace or an ornament, by no means implies plagiariſm. If they are introduced with fitneſs, there can be no charge of want of judgment. This is very different to uſing a viſible or ſtriking part of a compoſition, which no independent ſpirit would ſtoop to. Repreſentations of antient urns, armour, coſtumes, buildings, &c., will be of more value to the genuine artiſt than even the fineſt hiſtorical or other compoſition. A knowledge of the latter he ought to poſſeſs before he attempts to compoſe, and the utility of urns, armour, &c., will be obvious. Falling into imitation has produced what has been termed the *ſchools*, and ultimately proved their ruin; Nature ſufficiently revenges herſelf on thoſe who neglect her.

In the arts, as in every branch of ſtudy, the firſt thing we have to learn is what others have done, or, in other words, the preſent ſtate of human knowledge. Without this neceſſary information we ſhall ſtand as children only, and of courſe our improvement will be but ſlow; beſides, we ſhall have the mortification of finding our imaginary diſcoveries anticipated, and our labour fruitleſs. Another advantage will reſult from ſuch an inquiry, the learning how much experience is within the reach of diligence.

Imitation is the firſt part of painting, the ſecond is a judicious ſelection; but even in the imitative part we muſt cautiouſly ſhun objects deformed and baſe if we hope to poſſeſs the firſt taſte, and only copy ſuch as will teach us greatneſs, beauty, or accuracy. Such a conduct will enable us to reflect with wiſdom, and alſo to diſcover the cauſe, or from whence ariſe thoſe perfections by which we are moved. If in the courſe of our inquiry we find a perfection prevail through the whole of an artiſt's works ſo as to become a character, we may depend on it that was the kind of perfection ſought by the maſter; as in M. Angelo, greatneſs of ſtyle, knowledge of the figure, and foreſhortening; in Raphael,

phael, expreſſion, compoſition, and fine drapery; in Titian, colouring; in Parmegiano, grace; in Rubens, fine *chiaro-ſcuro*, &c. Among the Britiſh artiſts we may conſult Reynolds for grace, colour, and a fine *chiaro-ſcuro*; and in landſcape, the great Wilſon, Gainſborough, and Barret, and the works of many juſtly celebrated living artiſts. Much will depend on induſtry; if we ſee a grace or beauty in a maſter we muſt endeavour to make it our own, not merely by copying it, but by inveſtigating its cauſe, in which we ſhall be helped by imitation. If a compoſition ſtrikes, a ſketch of the whole may be made: ſo of the general diſpoſition of the colouring; for, after a certain facility of hand is obtained, we muſt depend on our own exertions; therefore laboriouſly copying great compoſitions would be only loſs of time. Studies from particular parts may be made, ſuch as are remarkable for ſome peculiar excellence; for, unfortunately, the beſt works have much of common-place matter in them. From what has been obſerved it will be evident we muſt, in the firſt inſtance, either go to, or ſuffer ourſelves to be guided to thoſe works of art time has ſtamped a value on, as it is eaſier to learn from that in which the choice is already made, remembering till we can go alone we muſt depend on the opinions of others. But the ultimate end of our inquiry muſt be *that independence reſulting from acting on an original principle*, or ſeeking thoſe perfections in nature with which art abounds, or, in other words, giving thoſe energies to the ſoul that leave it to act free of all reſtraint.

XXII. *On Baſaltes* *.

THAT the Giants' Cauſeway, ſituate near the northern extremity of the county of Antrim, is one of the greateſt natural curioſities, not only in Ireland, but on the ſurface of this globe, has long been acknowledged. It will therefore, I doubt not, gratify your readers to communicate to them ſome curious remarks on the different opinions of naturaliſts concerning the formation of the Giants' Cauſeway, with which the writer of this letter has been favoured by a gentleman of diſtinguiſhed learning and abilities, who has long made this wonderful production of nature the object of his diligent inveſtigation, and has diſcovered properties in it which had eſcaped former obſervers, not excepting the late ingenious Dr. William Hamilton, whoſe "Letters concern-

* From the Belfaſt News-letter.

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ing the Northern Coaſt of the County of Antrim," 1790, have ſo much merit, as muſt greatly aggravate our concern for his untimely fate *.

It will alſo, no doubt, afford great pleaſure, both to philoſophers and men of taſte, to learn that a very exact delineation of this great natural curioſity, painted in a capital ſtyle, has been finiſhed by Mr. Thomas Robinſon, now in Belfaſt, whoſe fine picture of the battle of Ballynahinch, at preſent in poſſeſſion of the marquis of Hertford, was ſo much admired. In this picture of the Giants' Cauſeway, Mr. Robinſon has not only done juſtice to its picturesque and ſtupendous forms, but has paid particular attention to ſome ſtriking peculiarities in its ſtructure, deſerving the notice of men of ſcience.

To the following remarks I ſhall prefix extracts from the account or deſcription given by Dr. Hamilton in his Letters, part ii. p. 26:

" The Giants' Cauſeway is generally deſcribed as a mole or quay, projecting from the baſe of a ſteep promontory ſome hundred feet into the ſea, and is formed of perpendicular pillars of baſaltes, which ſtand in contact with each other, exhibiting a ſort of polygon pavement, ſomewhat reſembling the appearance of a ſolid honeycomb. The pillars are irregular priſms of various denominations, from three to eight ſides †; but the hexagonal columns are as numerous as all the others put together.

" On a minute inſpection, every pillar is found to be ſeparable into ſeveral joints, whoſe articulation is neat and compact beyond expreſſion, the convex termination of one joint always meeting a concave ſocket in the next; beſides which, the angles of one frequently ſhoot over thoſe of the other, ſo that they are completely locked together, and can never be ſeparated without a fracture of theſe parts.

" The ſides of each column are unequal among themſelves, but the contiguous ſides of adjoining columns are always of equal dimenſions, ſo as to touch in all their parts.

" But it is not here that our admiration ſhould ceaſe: whatever the proceſs was by which Nature produced that beautiful and curious arrangement of pillars ſo conſpicuous about the Giants' Cauſeway, the cauſe, far from being limited to that ſpot alone, appears to have extended itſelf through a large tract of country in every direction; inſomuch that many

* He was murdered by a mob of aſſaſſins in 1797, with circumſtances of uncommon cruelty.

† Since Dr. Hamilton wrote, a few columns have been found of even nine ſides.

of

of the common quarries, for ſeveral miles around, ſeem to be only abortive attempts towards the production of a Giants' Cauſeway *."

I ſhall now ſubjoin the promiſed remarks, which are ſo original and ſatisfactory, that every judicious reader will join with the writer of this letter, in hoping that they will be reſumed and given to the public in a more extended form; and let me add that the teſtimony, of ſo accurate a judge, of the correctneſs of Mr. Robinſon's delineation, will raiſe it high in the opinion of perſons of ſcience †. A. B.

Remarks on the Accounts given by Naturaliſts of the Giants' Cauſeway.

The baſaltic pillars which in the laſt thirty years have been diſcovered in various parts of France and Germany, and the Hebrides, have excited much attention, and occaſioned many controverſies among modern naturaliſts.

The Giants' Cauſeway was the firſt aſſemblage of ſuch pillars that attracted notice, and is ſtill admitted by all to be the neateſt and moſt perfect group hitherto diſcovered; but in point of magnificence, the particular ſpot called the Giants' Cauſeway is inferior to many others on the ſame coaſt. Mr. Pennant probably knew of no other columns in the north of Ireland when he pronounced, that "baſalt pillars in Staffa far exceed the Iriſh in grandeur." He was little aware that our baſaltic country, and eſpecially our coaſt, exhibits many miles of vaſt perpendicular precipices, lined with baſalt columns, in parallel ranges, with a magnificence unrivalled in any other part of the world.

The colonade at Fairhead, on the coaſt of Antrim, is proved, in Nicholſon's Philoſophical Journal for December 1801, far to exceed Staffa in grandeur; its columns being each 250 feet long; that is, near five times as long as the talleſt pillars at Staffa.

Nor is our ſuperiority confined to the grandeur alone; our towering and extenſive precipices diſcloſe to the naturaliſt the materials and arrangement of the ſtrata of which this country

* Appearances of the ſame kind have occurred forty miles diſtant, near Dromore, in a quarry in the biſhop's demeſne land, which is beyond the limits marked in Dr. Hamilton's map of the baſalt country annexed to his letters. The country people here and in the north of England, and even naturaliſts in Scotland, uſe the term *whin-ſtone* as ſynonymous to baſalt. Porphyry, I preſume, is only another name for it.

† This picture is to be diſpoſed of by raffle to one hundred ſubſcribers at one guinea each, of which near ninety have given their names. Mr. Robinſon is a native of Windermere in Weſtmoreland, and was a pupil of Romney's. Of the poetical talents of him and his infant ſon, ſee the Gentleman's Magazine for February laſt, p. 156.

is compoſed, diſplaying a variety of the baſalt, of different forms and of a different principle of conſtruction, internal and external; ſuch as is not met with or not noticed in any other part of the world.

As we row along the baſe of theſe ſtupendous *façades*, we enjoy a ſcenery magnificent beyond deſcription, and diſcover many curious circumſtances which have hitherto eſcaped the notice of naturaliſts: I will mention one.

The Giants' Cauſeway, compared by Dr. Hamilton to a mole or quay, and ſuppoſed by Meſſrs. Deſmareſt and Raſpe to be a jet or current of lava running into the ſea from the baſe of a volcanic hill, now appears to be a part of one of the original ſtrata of our globe, placed at its interſection with the plane of the ſea. This ſtratum is forty-four feet thick, and entirely compoſed of baſalt pillars of that length: it is inclined to the horizon in a ſmall angle, and, when traced from the cauſeway eaſtward, aſcends obliquely along the face of the precipice. It culminates at the diſtance of about a mile from the cauſeway: its upper ſurface is now elevated near 250 feet above the ſurface of the ſea: proceeding eaſtward, it dips and finally emerges at Portmoon, two miles eaſt from the cauſeway, forming at its immerſion the vaſes of two beautiful conical iſlands.

Magnificent as the colonades may be ſuppoſed, which this ſtratum diſplays in ſo extenſive a courſe acroſs the face of theſe mighty precipices, they are by no means our fineſt; the ſtratum next but one above this is eleven feet thicker, and of courſe the pillars, of which it alſo is entirely compoſed, are fifty-five feet each, and its extent is ſomewhat greater than the former. The intermediate ſtratum is compoſed of another variety of baſalt, priſmatic, but not columnar: this is fifty-four feet thick.

The Giants' Cauſeway ſtratum, where it attains its greateſt height, is the eighth, counting from the ſea; all the lower ones emerge in ſucceſſion as we approach Portmoon; and, where this ſtratum finally emerges, it has eight over it, four of them columnar, the pillars being of very different lengths, determined by the thickneſs of the ſtratum. But in each ſeparate ſtratum the diameters of the pillars, and the perfection or imperfection of their conſtruction, appear pretty much the ſame, while the whole maſs of the ſtrata are ſteadily parallel to each other.

When I laſt ſummer found at the Giants' Cauſeway an ingenious and riſing artiſt, Mr. Robinſon, whom I knew to be highly favoured by my friend the biſhop of Dromore, employed to make a drawing of it, I at firſt thought I would have

have directed him to parts of the coaſt, which would have afforded him ſubjects of greater beauty as well as novelty. But, upon reflection, I think he has made the beſt choice, as the name of the Giants' Cauſeway will probably excite an attention to the ſubject and the artiſt, which more ſtupendous ſcenery could not have procured with ſuch as had not ſeen it. It remains, then, to relate a few particulars belonging to this wonderful production of nature, and to give a brief ſtatement of the controverſies to which it has given riſe among modern naturaliſts.

The Giants' Cauſeway has been often compared to a honeycomb, which it certainly reſembles much; but accurate obſervers find a very ſtriking difference between their component priſms. The powers of the bee ſeem to be limited; he can conſtruct his cell of no other figure than a regular hexagon, that is, with ſix ſides.

Mathematicians well know that the hexagon is the only regular figure (with more ſides than four), of which a number put together completely fill up ſpace.

Yet it appears that in the Giants' Cauſeway, the ſpace is completely filled without any ſuch limitation, figures of every number of ſides from three to eight (as Dr. Hamilton obſerves) being intermixed, yet the ſpace is as accurately filled up as in the honeycomb, and ſo cloſely as to hold water when a hollow in the ſurface ſuffers it to collect.

The extreme regularity of the Giants' Cauſeway pillars has much embarraſſed naturaliſts: ſome aſcribe their regularity to cryſtallization; but the celebrated Mr. Kirwan has ſhown that in many particulars theſe priſms differ from all known cryſtals.

Some modern philoſophers follow the opinion of a French naturaliſt, a M. Deſmareſt, who ſuppoſed the Giants' Cauſeway to be of volcanic origin, and that its regular priſms were formed in the currents of lava as they cooled. To this it has been ſtrongly objected that ſimilar figures have not been found in the currents of any known volcano.

Dr. Hamilton and M. Monnet allege that theſe priſms were formed in the heart of the volcano, at the bottom of its crater, and that we muſt wait until the mountain decays before we can diſcover them.

But they cannot have been formed there, as regular baſalt priſms abound on the tops of mountains, and alſo ſeveral ranges of them are found placed alternately one over the other, forming accumulations many ſtrata deep and moſt regularly diſpoſed, which, had they been in the crater of a volcano,

muſt have all melted into one maſs; beſides, theſe gentlemen make us wait too long for proof.

Mr. Raſpe, obſerving that the Giants' Cauſeway ran into the ſea, and conceiving it to be a current of lava, ſuppoſed that ſome unknown quality in the ſalt water, together with the ſudden cooling, occaſioned the material, of which it was compoſed, to aſſume regular forms.

But many currents of lava have been found in different parts of the world running into the ſea, while priſms, like thoſe at the Giants' Cauſeway, have not been obſerved at any of them.

An attentive examination of our coaſt ſhows the weakneſs of Mr. Raſpe's theory, though warmly adopted by M. Dolomieu; for, although baſalt pillars and colonades abound in the faces of our precipices hanging over the ſea for twenty miles, yet columnar baſalt comes into contact with the ſalt water but in three points; to wit, the two interſections of the Giants Cauſeway ſtratum mentioned above, and at Carrickarede, five miles eaſtward.

Dr. Hutton, adhering to the igneous ſyſtem, but giving up the uſual mode of producing lava by volcanic eruption, affirms that all baſalt (the ſtone of which the Giants' Cauſeway is formed) is lava, firſt fuſed, and then conſolidated in the bowels of the earth, whence it was elevated to its ſurface, and to the tops of our mountains, by the expanſive force of ſubterranean fire.

Wild as this faſhionable theory muſt appear, and contrary to all probability, it is alſo unſupported by any ſpecies of proof, and contradicted by facts in every part of this country; for, inſtead of the diſlocation and contorſion of the ſtrata, which, according to his theory, he ſays, we muſt expect, (Edinburgh Tranſactions, vol. i. p. 265,) and inſtead of finding them, as he ſays we do, "in every poſſible poſition, from horizontal becoming vertical, from continuous broken and ſeparated in every poſſible direction, from a plane bent and doubled," nothing can exceed the regularity with which the ſtrata are diſpoſed over the whole face of this baſalt country, nor does their ſteady parallelifm ſeem ever to be diſturbed.

Though baſalt has for a long time been pretty generally conſidered as a volcanic production, yet more accurate modern obſervers have diſcovered many circumſtances which ſhow it never could have been in fuſion; for inſtance,

All lavas abound with air-holes, while not a ſingle cavity is to be found in any of our baſalts, except what are mentioned below.

All lavas are accompanied by ſcoria, not a particle of which is to be found at the Giants' Cauſeway, or any where on our coaſt *.

Currents of lava are ſtated by Sir William Hamilton, Ferber, and Spalanzani, always to vary in their denſity, their materials being generally arranged according to their ſpecific gravities: thus, at the bottom compact lava, then cellular lava, then ſcoria, laſtly cinders and volcanic aſhes. Now, if baſalt be of volcanic origin, our ſtrata muſt be currents of lava, of courſe ſhould be governed by the ſame rule; inſtead of which, every baſalt ſtratum here is of uniform denſity and uniform material from top to bottom.

Marine ſhells and their impreſſions have lately been diſcovered in ſome of our baſalts †: this proves they never were in fuſion, as ſuch ſubſtances calcine and turn into lime with a very moderate heat.

Baſalt pillars have alſo been lately found with cavities filled with freſh water; a fact incompatible with igneous fuſion ‡.

Mr. Kirwan derives every thing from aqueous ſolution; and ſays, that the material of which our cauſeway is formed was ſplit into columns by deſiccation.

Eminent as this great man undoubtedly is in the chemical and mineralogical branches of natural hiſtory, yet on this ſubject his theory ſeems to be as inſufficient as thoſe of any of his predeceſſors; for his ſyſtem does not account for the delicate articulations of our pillars, by far the moſt curious circumſtance attending them, and moſt happily exhibited in different points of view in the preſent picture.

This theory, too, is incompatible with the different ranges or ſtrata of pillars placed on one another with ſolid rock between them.

But, above all, it is contradicted by fact, our pillars being

* Some travellers have thought they obſerved veſtiges of fire and ſcoria of iron; but, if they had broke the ſtones, they would have found they had been deceived by the exterior appearance, and that the internal ſtructure was incompatible with any ſuch principle. Some ſtones which have been picked up on our coaſt have been produced as exhibiting real marks of fire; but theſe had been uſed in forming hearths for the burning of kelp.

† Theſe had not been diſcovered when Dr. Hamilton's book was publiſhed.

‡ That ſuch water could not poſſibly have got through any chinks or clefts between the baſalt columns will be ſhown below; for nothing can be more compact and cloſely joined, ſo as not to admit the minuteſt interval. Indeed, this water is always found as a kind of nucleus, within the moſt compact part of the ſtone, and incloſed in a glazed covercle or gloſſy ſhell, which ſeems to have formed its nidus from the firſt formation of its ſtony bed.

in cloſe contact with each other, as appears by their ſurface holding water; whereas, had they been formed by their ſubſtance ſplitting on deſiccation, great intervals muſt have exiſted between them.

From all this it muſt appear that philoſophers have not yet diſcovered the proceſs adopted by nature in the conſtruction of this beautiful and ſtupendous work; but, though we cannot penetrate the ſecret of her operations, it is with pleaſure we admire her magnificence, eſpecially when joined to the moſt conſummate neatneſs; and where are both ſo abundantly diſplayed as at the Giants' Cauſeway and its vicinity? The toils of a journey are amply repaid by the contemplation of ſuch wonderful objects; and to thoſe who are too diſtant for ſuch an expedition, Mr. Robinſon's fine picture, finiſhed on the ſpot, and now at Belfaſt, will give a better idea of the Giants' Cauſeway, and its towering promontories, than any thing of the kind yet attempted. W. R.

XXIII. *Experiments and Obſervations on certain Stony and Metalline Subſtances which at different Times are ſaid to have fallen on the Earth; alſo on various Kinds of Native Iron.* By EDWARD HOWARD, *Eſq. F. R. S.*

[Continued from p. 31.]

IT remains for me to ſpeak of a ſubſtance mentioned in the *Lithophylacium Bornianum*, part i. p. 125, deſcribed thus:—"Ferrum retractorium, granulis nitentibus, matrice vireſcenti immixtis, (*Ferrum virens* Linn.,) cujus fragmenta, ab unius ad vigenti uſque librarum pondus, cortice nigro ſcoriaceo circumdata, ad Plaun, prope Tabor, circuli Bechinenſis Bohemiæ, paſſim reperiuntur."

The iron thus deſcribed is moreover made remarkable by a note *, which obſerves, that credulous people aſſert it to have fallen from heaven, during a thunder ſtorm, on the 3d of July 1753.

The collection of baron Born, it is well known, has a place in the cabinet of the right hon. Charles Greville, who, from the effect produced by comparing the hiſtories and ſtructure of the Italian and Yorkſhire ſtones with the deſcription of this iron, was induced to ſearch the collection of Born, where he diſcovered the very ſubſtance aſſerted to have fallen

* Quæ (fragmenta) 3 Julii, anni 1753, inter tonitrua, e cœlo pluiſſe creduliores quidam aſſerunt.

on

on the 3d of July 1753. How far theſe four ſubſtances have reſemblance to each other, it will ſoon appear not to be my province to anticipate.

The preſident having done me the honour to ſubmit his ſpecimens of the Yorkſhire and Italian ſtones to my examination, I became indebted to Mr. Greville and Mr. Williams for a ſimilar diſtinction: and, being thus poſſeſſed of four ſubſtances, to all of which the ſame origin had been attributed, the neceſſity of deſcribing them mineralogically did not fail to preſent itſelf. To execute this taſk, no one could be more eager, and certainly no one better qualified, than the count de Bournon. He has very obligingly favoured me with the following deſcriptions.

Mineralogical Deſcription of the various Stones ſaid to have fallen upon the Earth. By the Count de Bournon, F.R.S.

The ſtones I am about to deſcribe are not of any regular ſhape; and thoſe which were found in an entire ſtate, that is, thoſe which had not been broken, either by their fall or otherwiſe, were entirely covered with a black cruſt, the thickneſs of which was very inconſiderable.

The ſtones which fell at Benares are thoſe of which the mineralogical characters are the moſt ſtriking: I ſhall therefore begin the following deſcription with them; and ſhall afterwards make uſe of them, as objects of compariſon, in deſcribing the others.

Stones from Benares.

Theſe ſtones, as well as the others deſcribed in this paper, whatever may be their ſize, are covered over the whole extent of their ſurface with a thin cruſt of a deep black colour: they have not the ſmalleſt gloſs; and their ſurface is ſprinkled over with ſmall aſperities, which cauſe it to feel, in ſome meaſure, like ſhagreen, or fiſh-ſkin.

When theſe ſtones are broken, ſo as to ſhow their internal appearance, they are found to be of a grayiſh aſh colour; and of a granulated texture, very ſimilar to that of a coarſe grit-ſtone: they appear evidently to be compoſed of four different ſubſtances, which may be eaſily diſtinguiſhed by making uſe of a lens.

One of theſe ſubſtances, which is in great abundance, appears in the form of ſmall bodies, ſome of which are perfectly globular, others rather elongated or elliptical. They are of various ſizes, from that of a ſmall pin's head to that of a pea, or nearly ſo; ſome of them however, but very few, are of a larger ſize. The colour of theſe ſmall globules is

gray, ſometimes inclining very much to brown; and they are completely opaque. They may, with great eaſe, be broken in all directions: their fracture is conchoid, and ſhows a fine, ſmooth, compact grain, having a ſmall degree of luſtre, reſembling in ſome meaſure that of enamel. Their hardneſs is ſuch, that, being rubbed upon glaſs, they act upon it in a ſlight degree; this action is ſufficient to take off its poliſh, but not to cut it: they give faint ſparks when ſtruck with ſteel.

Another of theſe ſubſtances, is a martial pyrites, of an indeterminate form; its colour is a reddiſh yellow, ſlightly inclining to the colour of nickel, or to that of artificial pyrites. The texture of this ſubſtance is granulated, and not very ſtrongly connected: when powdered, it is of a black colour. This pyrites is not attractable by the magnet; and is irregularly diſtributed through the ſubſtance of the ſtone.

The third of theſe ſubſtances conſiſts in ſmall particles of iron in a perfectly metallic ſtate, ſo that they may eaſily be flattened or extended by means of a hammer. Theſe particles give to the whole maſs of the ſtone the property of being attractable by the magnet; they are, however, in leſs proportion than thoſe of pyrites juſt mentioned. When a piece of the ſtone was powdered, and the particles of iron ſeparated from it, as accurately as poſſible, by means of a magnet, they appeared to compoſe about $\frac{2}{100}$th of the whole weight of the ſtone.

The three ſubſtances juſt deſcribed are united together by means of a fourth, which is nearly of an earthy conſiſtence. For this reaſon, it is eaſy to ſeparate, with the point of a knife, or even with the nail, the little globular bodies above mentioned, or any other of the conſtituent parts of the ſtone we may wiſh to obtain. Indeed the ſtone itſelf may readily be broken merely by the action of the fingers. The colour of this fourth ſubſtance, which ſerves as a kind of cement to unite the others, is a whitiſh gray.

The black cruſt with which the ſurface of the ſtone is coated, although it is of no great thickneſs, emits bright ſparks, when ſtruck with ſteel: it may be broken by a ſtroke with a hammer, and ſeems to poſſeſs the ſame properties as the very attractable black oxide of iron. This cruſt is, however, like the ſubſtance of the ſtone, here and there mixed with ſmall particles of iron in the metallic ſtate: they may eaſily be made viſible by paſſing a file over the cruſt, as they then become evident on account of their metallic luſtre. This is more particularly the caſe with reſpect to the cruſt of thoſe ſtones which remain to be mentioned, they being much more

more rich in iron than that I have juſt deſcribed; a circumſtance I think it needleſs to repeat in the following deſcriptions of them. The ſtone now treated of, does not, when breathed upon, emit an argillaceous ſmell: the ſame remark may be applied to all the others.

The ſpecific gravity of this ſtone is 3352.

Stone from Yorkſhire.

This ſtone, the conſtituent parts of which are exactly the ſame as thoſe of the ſtones from Benares, differs from them, however,

Firſt, In having a finer grain.

Secondly, That the ſubſtance deſcribed as being in the form of ſmall globular or elliptical bodies, is not ſo conſtantly in thoſe forms, but is alſo found in particles of an irregular ſhape; a circumſtance that is not met with in the other ſtones: theſe bodies are likewiſe, in general, of a ſmaller ſize.

Thirdly, The proportion of martial pyrites, which has preciſely the ſame characters as that in the ſtones from Benares, is leſs; on the contrary, that of the iron in the metallic ſtate is much greater. The quantity I was able to ſeparate by means of the magnet, appeared to me to compoſe about eight or nine parts, in one hundred, of the weight of the whole maſs. I obſerved many pieces of this iron, of a pretty conſiderable ſize; one of them, taken from a portion of the ſtone I had powdered in order to ſeparate the iron, weighed ſeveral grains.

The part of the ſtone which is in an earthy ſtate, and which ſerves to connect the other parts together, has rather more conſiſtence than that of the preceding ſtones; and its appearance does not differ much from that of decompoſed felſpar or kaolin. The ſtone itſelf, therefore, although by no means hard, is rather more difficult to break with the fingers.

The ſpecific gravity of this ſtone is 3508.

Stone from Italy.

This ſtone was in a perfectly entire ſtate; conſequently, its whole ſurface was covered over with the black cruſt peculiar to all ſtones of this kind. As the ſtone was of a very ſmall ſize, it became neceſſary to ſacrifice the whole of it to the inveſtigation of its nature. Its grain was coarſe, ſimilar to that of the ſtones from Benares: in it might be perceived the ſame gray globular bodies, the ſame kind of martial pyrites, and the ſame particles of iron in the metallic ſtate. The proportion

proportion of theſe laſt was much leſs than in the ſtone from Yorkſhire, but rather greater than in the ſtones from Benares. The ſame kind of gray earthy ſubſtance ſerved to connect the different parts together; and nothing more could be perceived, except a few globules, which conſiſted wholly of black oxide of iron, attractable by the magnet, and one ſingle globule of another ſubſtance, which appeared to differ from all thoſe we have already deſcribed. This laſt ſubſtance had a perfectly vitreous luſtre, and was completely tranſparent: it was of a pale yellow colour, ſlightly inclining to green; and its hardneſs was rather inferior to that of calcareous ſpar. The quantity of it, however, was too ſmall to be ſubmitted to ſuch an inveſtigation as might have determined its nature. The black cruſt which covered the ſtone was rather thinner than that of the ſtones already deſcribed; and ſeemed to have undergone a kind of contraction, which had produced in it a number of fiſſures or furrows, thereby tracing upon the ſurface the appearance of compartments, ſimilar in ſome meaſure to what is obſerved in the ſtones called *ſeptaria*.

The ſpecific gravity of this ſtone was 3418.

Stone from Bohemia.

The internal ſtructure of this ſtone is very ſimilar to that of the ſtone from Yorkſhire. Its grain is finer than that of the ſtones from Benares: in it may be obſerved the ſame gray ſubſtance, both in ſmall globules and in particles of an irregular ſhape; alſo the ſame particles of metallic iron. The ſame kind of earthy ſubſtance likewiſe ſerved to connect the other parts together.

This ſtone, however, differs materially from the others.

Firſt, The particles of pyrites cannot be ſeen without a lens.

Secondly, It contains a much larger quantity of iron in the metallic ſtate; inſomuch, that the proportion of that metal, ſeparated from it by means of the magnet, amounted to about $\frac{25}{100}$ths of the weight of the whole.

This ſtone has alſo (owing, perhaps, to its having remained a much longer time in the earth than the preceding ones, all of which were taken up nearly at the very inſtant of their fall,) another difference, viz. many of the particles of iron in a metallic ſtate have undergone an oxidizement at their ſurface; a circumſtance that has produced a great number of ſpots of a yellowiſh brown colour, and very near to each other, over a part of its internal ſubſtance. This oxidizement, by adding to the bulk, and to the force of action, of the part we have deſcribed as ſerving by way of cement to

the other conſtituent parts of the ſtone, has occaſioned a greater degree of adheſion between theſe parts, and has rendered the ſubſtance of the ſtone more compact.

The great quantity of iron in a metallic ſtate which this ſtone contains, added to its greater compactneſs, makes it capable of receiving a ſlight degree of poliſh; whereas it is impoſſible to give any poliſh to the others. When poliſhed, the iron becomes very evident, in the poliſhed part; appearing in the form of ſmall ſpecks, almoſt cloſe to each other, which have the colour and luſtre peculiar to that metal: theſe ſpecks are, in general, nearly of an equal ſize.

The black cruſt of this ſtone is ſimilar to that of the others.

The ſpecific gravity of the ſtone is 4281.

It is eaſy to perceive, from the foregoing deſcription, that theſe ſtones, although they have not the ſmalleſt analogy with any of the mineral ſubſtances already known, either of a volcanic or any other nature, have a very peculiar and ſtriking analogy with each other. This circumſtance renders them truly worthy to engage the attention of philoſophers, and naturally excites a deſire of knowing to what cauſes they owe their exiſtence.

I proceed to conſider the aſſiſtance to be derived from chemiſtry, in diſtinguiſhing theſe ſtones from all other known ſubſtances, and in eſtabliſhing the aſſertion, that they have fallen on the earth.

The analyſis made by the French academicians of the ſtone preſented to them by the abbé Bachelay, was, in part, conducted by the ever to be deplored Lavoiſier; but it was performed before that celebrated author had enriched chemiſtry with his laſt diſcoveries, and before he had given birth to the ſyſtem under which it flouriſhes. The reſult of this analyſis might well induce the concluſion, that the ſubject of it was common pyritical matter. It was unfortunately made of an aggregate portion of the ſtone, and not of each diſtinct ſubſtance, irregularly diſſeminated through it. The proportions obtained were, conſequently, as accidental as the arrangement of every ſubſtance in the maſs.

The analyſis of M. Barthold, of the ſtone of Enſiſheim, is ſubject to the ſame objections; but, after having the advantage of the foregoing deſcriptions, the reſearches which follow cannot be ſuppoſed altogether liable to a ſimilar fatality.

[To be continued.]

XXIV. *On*

XXIV. *On the different Proportions of Carbon which conſtitute Crude Iron and Steel.* By DAVID MUSHET, *Eſq. of the Calder Iron Works* *.

MY laſt communication contained ſeveral experiments to prove the quantity of carbon abſorbed by pure malleable iron in paſſing into the carbonated crude ſtate. The object of the preſent will be to exhibit the proportions of carbon which enter into the compoſition of the other varieties of crude iron and caſt ſteel. I continue the numeration of the experiments from my laſt:

	Grs.
Exp. VII. Swediſh bar iron - -	1174
Charcoal $\frac{1}{15}$th part, or 78 grs.	

A fuſion was obtained from this mixture, after which there remained only a ſmall portion of charcoal, too minute for weighing.

The metallic button weighed -	1213
Gained in weight by the combination of charcoal equal to $\frac{1}{30}$th part the weight of the iron.	39
Weight of the iron 1174, and charcoal 78, =	1252
Weight of the button - -	1213
Total loſs of weight in the fuſion	39

equal to that gained by the iron. Upon minute inſpection, no part of the ſurface of this button was carbonated. The colour was blueiſh black, ſmooth in the centre but a little oxidated towards the edges. Its fracture preſented cloſe dark gray crude iron. The cryſtals much cloſer and more minute than in thoſe experiments where richly carbonated crude iron was obtained. Appreciating its real quality by compariſon with crude iron manufactured for ſale, it occupied that rank generally known by the names of No. II. gray melting pig iron.

	Grs.
Exp. VIII. Swediſh bar iron - -	922
Charcoal $\frac{1}{20}$th part, or 46 grs.	

From the expoſure of this mixture there reſulted a very perfect metallic button whoſe upper ſurface preſented a partial degree of radiated cryſtallization. It was found to weigh - - - 950

Gained in weight by the combination of carbon equal to $\frac{1}{33}$d part the original weight of the iron. The fracture of this button was ſmooth, ſilvery white, occaſionally ſtudded with carbonaceous ſpecks in the form of ſmall 28

* Communicated by the Author.

grains,

grains, an exact resemblance to mottled pig iron. In this experiment there remained not the most distant trace of carbonaceous matter. A small portion of amber-coloured glass was formed round the edges of the metal.

	Grains.
Weight of the iron 922, charcoal 46, = -	968
Metal resulting - -	950
Total loss of weight	18

	Grains.
Exp. IX. Swedish bar iron - -	1330
Charcoal $\frac{1}{20}$th part, or 53 grs.	
From this mixture a perfect fusion and metallic button was obtained, which weighed - -	1351

Gained in weight by the combination of carbon 21 equal to $\frac{1}{63}$d part the weight of the iron. In this experiment also the charcoal had completely disappeared. The upper surface of the button was smooth, the under surface considerably pitted. The concaves chequered with a rude crystallization peculiar to cast iron. The fracture of this metallic mass was bright silvery white, destitute of grain, and exhibiting a very perfect streaky crystallization slightly radiated. Its resemblance was strikingly similar to that of highly blown cast iron prepared in the finery for the purposes of bar iron making; an operation commonly in use for the purpose of decarbonating the iron, that it may, in the subsequent process, sooner pass into the state of malleability. The weight of iron and charcoal in the experiment amounted to grs. 1383

Iron obtained - -	1351
Total loss in the fusion	32

Exp. X. Swedish iron - -	1348
Charcoal $\frac{1}{30}$th, or 45 grs.	
From this proportion of mixture in half an hour a perfectly fused button of metal was obtained, which was found to weigh - - -	1359

Gained in weight by the combination of carbon 11 equal to $\frac{1}{72\frac{1}{2}}$d part the original weight of the iron. The upper surface of this button was smooth without configuration. Below the surface was uneven, and covered with minute but perfect crystallization. Its fracture was blueish silvery white, composed of flat dazzling crystals, proceeding in lines

lines from a centre to the edges of the button. Here it was moſt obvious, that from the ſmallneſs of the proportion of carbon preſented to the iron, the reſulting product was found aſſuming the earlieſt ſtage of granulation approaching to the ſteely ſtate. The brilliant concretions obſervable in the ſurface of the button were too indiſtinct and flat for ſteel capable of withſtanding the hammer.

	Grains.
The joint weight of the iron and charcoal amounted to	1393
Iron obtain - - -	1359
Total loſs of weight in the fuſion	34

Exp. XI. Swediſh iron - - 1502
Charcoal $\frac{1}{50}$th, or 37 grs.
The metallic button obtained by the fuſion of this mixture weighed - - - 1505

Gained in weight by the union of carbon 3
equal to $\frac{1}{500}$th part the firſt weight of iron. The upper ſurface of this button was ſmooth, with a faint impreſſion of a chequered cryſtallization. The under ſurface poſſeſſed ſome large pits, ſimilarly, though more perfectly cryſtallized.

The fracture poſſeſſed one ſhade of blue beyond that of No. X. A regular granulated ſurface compoſed of flat oblong cryſtals was obſervable, ſtill too indiſtinct and too much on edge for workable ſteel. The weight of charcoal and iron in this experiment amounted to grs. 1539
Metal obtained - - 1505
Total loſs of weight in the fuſion 34

Exp. XII. Swediſh iron - - 1537
Charcoal $\frac{1}{50}$th, or 31 grs.
From the expoſure of this mixture, a metallic button was obtained, which weighed - - 1533

Loſt in fuſion, equal $\frac{1}{350}$th part. 4
The ſurfaces of this button were uniformly ſmooth. The fracture was denſe, and diſplayed a grain peculiar to highly ſaturated bliſtered ſteel. When put under the hammer, with a low red heat, it ſtood a few blows, but afterwards parted.
Weight of mixture employed in the experiment grs. 1568
Steel obtained - - 1533
Total loſs of weight 35

Exp.

Exp. XIII. Swediſh iron - - 1362
Charcoal $\frac{1}{20}$th, or 15 grs.
A very fine fuſion was produced from the expoſure of this mixture. The metallic button was found to weigh 1319

Loſt in fuſion, equal to $\frac{1}{31\frac{9}{10}}$th part, 43

This button preſented a wavy cryſtallized ſurface. The under ſurface was rough, and contained one large pit accurately cryſtallized. The fracture was regularly granulated, ſmall, but diſtinct, of a light blueiſh colour. The cryſtals, though diſtinct, were not ſo prominent as thoſe of eaſy drawing caſt ſteel. It, however, hammered with the uſual degree of caution neceſſary to the working of caſt ſteel. The bar of ſteel formed from the button poſſeſſed all thoſe properties requiſite for file making, and other purpoſes requiring a quality highly charged with carbonaceous matter.

	Grains.
Weight of the mixture - -	1377
Steel obtained - - -	1319
Loſs of weight in this experiment	58

Exp. XIV. Swediſh iron - - 1372
Charcoal $\frac{1}{100}$th, or 14 grs.
The button obtained weighed - - 1312

Loſt in the fuſion 60

equal to $\frac{1}{22\frac{8}{10}}$th part the original weight of the iron. The ſurface of this button was ſmooth, without cryſtallization. The under ſurface rough, and poſſeſſed of one large pit in the centre, faintly marked with the uſual cryſtalline appearance. The fracture preſented regular light blue grains, diſtinct, and more prominent than No. XIII. One-half of the button was drawn into a neat ſquare bar, and proved ſteel of an excellent quality. One end of the bar being looſe and ſhaled, welded tolerably well, and hardened afterwards with a low heat. In appreciating the quality of this reſult, it appeared to be that kind of ſteel ſuitable for penknives, razors, &c., poſſeſſed of neither the extremes of hardneſs nor of ſoftneſs.

Beyond the proportion of $\frac{1}{100}$th part of charcoal to iron, I continued the experiment till the proportion was reduced to $\frac{1}{200}$th part. It would appear tedious to detail theſe experiments, the moſt intereſting being already minutely deſcribed. In the ſame progreſſive manner, by diminiſhing the

the dose of carbon, the metallic result approached more and more to the softness of malleable iron, though by no means possessed of all its properties. In this series of experiments, iron presented with $\frac{1}{150}$th part its weight of charcoal was found to form very soft steel fit for making scissars, &c., which, in a good workman's hands, would have doubled, welded, and formed a very perfect point, afterwards hardening so as to display a beautiful close break of steel. By using the following precaution, it was even found capable of welding perfectly to iron. Two flat bars of a similar shape, one of this quality of steel, and one of good malleable iron, were put under the hammer with a good welding heat. After a few light blows, the junction was completely made. The united bars were allowed to cool without further hammering till the shade of heat was bright red. The whole piece was then drawn out in a solid compact form, whose fracture, when cold, presented a complete junction of the iron and steel, exhibiting at the same time their respective grains.

When iron is presented in fusion to $\frac{1}{140}$th or $\frac{1}{150}$th part of its weight of charcoal, the resulting product occupies a kind of middle state betwixt malleable iron and steel. It then welds with facility, and, provided the precaution formerly mentioned is attended to, may be joined either to iron or steel, at a very high welding heat. Thus combined with carbon, it is still susceptible of hardening a little, but without any great alteration in the fracture. It possesses an uncommon degree of strength and tenacity, capable of an exquisite degree of polish, arising from its complete solidity and the purity of fracture conveyed to it by fusion.

When the dose of carbon is further diminished, and in the ratio of this diminution, the same steel or iron becomes more and more red short, and less capable of cohesion under a welding heat, so that, when the proportion is reduced to $\frac{1}{200}$th part the weight of the iron, the quality resulting is nearly analogous to the fusion of iron *per se*, or that obtained by the fusion of iron and earths.

It will appear evident from the result of these and former experiments, that crude iron and steel only differ from each other in the proportions of the carbon they contain. In the details now before us, charcoal alone is used in addition to the malleable iron as pure as is ever made, to effect every principal stage or modification of the metal. Hence we conclude, that

Iron semi-steelified is made with, charcoal, $\frac{1}{150}$th part.
Soft cast steel, capable of welding, with, - $\frac{1}{120}$th
Cast steel, for common purposes, with, - $\frac{1}{100}$th

Cast

Caſt ſteel requiring more hardneſs, with, of charcoal, - - - - $\frac{1}{90}$th part.
Steel capable of ſtanding a few blows, but quite unfit for drawing, - - $\frac{1}{50}$th
Firſt approach to a ſteely granulated fracture, is from - - - $\frac{1}{37}$th to $\frac{1}{40}$th
White caſt iron - - $\frac{1}{25}$th
Mottled caſt iron - - $\frac{1}{25}$th
Carbonated caſt iron - - $\frac{1}{15}$th
And ſupercarbonated crude iron - $\frac{1}{12}$th, or when any greater quantity is uſed.

Although this is the quantity of charcoal neceſſary to form theſe various qualities of metal by this mode of ſyntheſis, yet we are by no means authorized to conclude that this is the proportion of real carbonaceous matter taken up by the iron, ſeeing that in experiments No. I. to No. VI. inclufive, the weight gained by the iron was upon the average equal only to $\frac{1}{21\frac{8}{10}}$th part; whereas the charcoal which diſappeared in the different fuſions amounted to 61.1 per cent. of the original quantity introduced along with the iron.

In the ſucceeding experiments the following differences are remarkable:

No. VII.	Charcoal uſed	$\frac{1}{15}$th	-	Iron gained	$\frac{1}{30}$th part.
No. VIII.	-	$\frac{1}{20}$th	-	-	$\frac{1}{33}$d
No. IX.	-	$\frac{1}{25}$th	-	-	$\frac{1}{65}$d
No. X.	-	$\frac{1}{30}$th	-	-	$\frac{1}{122\frac{1}{2}}$
No. XI.	-	$\frac{1}{40}$th	-	-	$\frac{1}{500}$th
No. XII.	-	$\frac{1}{50}$th	-	Iron loſt	$\frac{1}{354}$th
No. XIII.	-	$\frac{1}{90}$th	-	-	$\frac{1}{36\frac{5}{10}}$th
No. XIV.	-	$\frac{1}{100}$th	-	-	$\frac{1}{22\frac{8}{10}}$th

From this we ſee that when a proportion of charcoal equal to $\frac{1}{40}$th part, and above, the weight of the iron is uſed, the latter always gains in weight; but when a more ſparing proportion is introduced, room is left for the exertion of another affinity upon the metal, and it conſequently and invariably loſes in weight proportioned to the diminution of the carbon. I have here further to remark upon the foregoing experiment, and upon the nature of experiments by ſyntheſis performed in this way in general, that the reſults as to quality will differ materially when different portions of matter are uſed. So that an operator repeating the above experiments either in

crucibles ſmaller or larger, or with a greater or leſs weight of mixture, would not obtain the ſame reſults.

The formation of caſt ſteel in the large way, founded upon the reſults of the foregoing experiments, affords an inconteſtable proof of this. In fuſions of 18, 22, and 25 lbs. of iron each, we are obliged to increaſe the doſe of carbon conſiderably beyond that requiſite in ſmall experiments. To form ſteel equal to that obtained in experiment XIII. wherein $\frac{1}{70}$th of charcoal was uſed, $\frac{1}{53}$th part is requiſite to be introduced. For ſteel ſimilar to that in experiment XIV. $\frac{1}{65}$th and $\frac{1}{70}$th part are uſed. For ſofter ſteel $\frac{1}{70}$th, whereas in the ſmall experiment $\frac{1}{120}$th part was ſufficient. If in the manufacturing a ſmall extra quantity of carbon is requiſite, this is ſaved by the comparatively ſmall loſs ſuſtained in the tranſmutation of the iron into ſteel.

Many inſtances have occurred in the firſt fuſion from a caſt ſteel pot in the large way, where 25 lbs. of iron, and its requiſite proportion of carbon, not exceeding $\frac{1}{70}$th, have afforded an ingot of caſt ſteel weighing 24 lbs. 12, 13, 14, and 15 ounces, being a loſs equal to no more than $\frac{1}{110}$th, $\frac{1}{200}$th, $\frac{1}{370}$th, $\frac{1}{400}$th part the weight of the iron, whereas in experiments No. XIII. and XIV. the loſs of metal amounted to $\frac{1}{31\frac{6}{10}}$th, and $\frac{1}{22\frac{8}{10}}$th part the weight of the iron.

I ſhall conclude this paper with a few remarks upon the ſtate in which carbon exiſts in ſteel and in crude iron.

When malleable iron is fuſed with $\frac{1}{130}$th or $\frac{1}{140}$th part of its weight of carbon, the reſulting product is conſiderably ſteelified. The fracture is lighter in the colour than it formerly was in the ſtate of iron. When fuſed with an 80th to $\frac{1}{102}$th, ſteel of an ordinary quality is produced, the fracture of the metal ſtill becoming whiter. When the doſe of carbon is increaſed beyond this, the ſteel becomes ſo hard and denſe as to be unfit for hammering. The fracture now will be found approaching to the colour of ſilver, and loſing its granulated appearance, aſſuming, however, a cryſtallized form. In this ſtate the metal will be found to reſiſt the hammer and file, and to be unfit for any purpoſe. Increaſe, however, the quantity of carbon to $\frac{1}{12}$th or $\frac{1}{15}$th, the reſulting product is no longer deſtitute of grain, nor poſſeſſed of the ſame degree of hardneſs. The fracture will be found gray, and the ſurface eaſily reduced by the pile. A further increaſe of the carbon is accompanied by an increaſe of theſe properties. At 1-8th or 1-6th, the filings of the metal, when thrown into water, leave a carbonaceous pellicle covering the whole ſurface, and of a conſiderable thickneſs.

Thus

Thus we find that carbon hardens iron till it arrives at the higheſt pitch of denſity, which is indicated by the metal loſing grain, and aſſuming a cryſtallized ſilvery fracture. At this point or maximum we may conceive that the reſpective proportions of mixtures are ſo nearly balanced that the affinity exerted by the iron is juſt ſufficient to deoxidate the charcoal, and that hitherto nothing but pure carbon ſimilar to the diamond has combined with the iron. If, however, the equilibrium is deſtroyed by a larger portion of charcoal, then we find the affinity too weak to deoxidate the whole, and part of it unites in the ſtate of an oxide of carbon; at firſt conſtituting a mottled fracture, and afterwards, as the doſe is increaſed, all thoſe deepening blueiſh gray ſhades peculiar to ſoft caſt iron. Hence carbon or its oxide again ſoftens iron. It never, however, reſtores the properties of forging or of hammering. One invariable law, however, is maintained, that the fuſibility of iron under every circumſtance and modification is in the ratio of the quantity of carbon united.

XXV. *Reſearches relative to the Moon's Influence on the Atmoſphere and on the Variations of the Barometer. By* C. Cotte, *Member of different Learned Societies* *.

DURING forty years ſtudy of meteorology I have conſtantly viewed, with a peculiar degree of intereſt, the influence of the moon upon our atmoſphere.

The opinion of this influence is founded upon a prejudice ſo antient, that I thought it worth while to endeavour, by means of reſearches and combinations of facts, eſtabliſhed on the baſis of obſervations contained in our regiſters, to diſcover, not a complete ſyſtem, but the proper data to conduct us, by degrees, to the ſolution of the problem.

The reſults of my endeavours in this way may be peruſed, 1ſt, in my Treatiſe on Meteorology, publiſhed in 1774, p. 186, 302, 317, note; 280, 606: 2dly, in my Memoirs on Meteorology, publiſhed in 1788, vol. i. p. 100, &c. vol. ii. p. 80: 3dly, in the *Journal de Phyſique* 1782, part ii. p. 249; 1786, part i. p. 276; 1792, part ii. p. 272; 1793, part i. p. 279; 1800, part i. p. 358, part ii. p. 337; 1801, part i. p. 338, part ii. p. 221, 409.

The new reſearches which I now offer to the public have

* From *Journal de Phyſique*, &c. tom. liv. Prairial, an. 10.

been occaſioned by reading in the *Bibliotheque Britannique (Sciences et Arts,* tom. xix. p. 227, Mars 1802), an extract of a memoir of Mr. Luke Howard on a periodical variation of the barometer, apparently due to the influence of the ſun and moon on the atmoſphere, extracted from the Philoſophical Magazine.

The author eſtabliſhes his concluſions upon a year's obſervations made in 1798 at Plaiſtow in Eſſex, about five miles eaſt of London, and on ten years of ſimilar obſervations made at London, and recorded in the Tranſactions of the Royal Society from 1787 to 1796.

In order to be more readily underſtood by ſpeaking to the eye, Mr. Howard has given a plate divided into lunar weeks according to the four principal phaſes of the moon, on which are engraved two curves which repreſent the courſe of the mercury in the barometer. One of theſe, which is dotted, repreſents the courſe of the barometer as obſerved at Plaiſtow in 1798; the other is a line indicating the variations of the barometer at London, correſponding to each of the principal plans on a mean of ten years *.

M. Begnelin at Berlin, and M. Maret at Dijon, have long ſince adopted charts of this kind to repreſent the courſe of the barometer and thermometer. M. M. A. Pictet mentions having drawn out one in 1774, in order to compare the contemporary movements of the barometer at Geneva and Bordeaux.

I likewiſe prepared a large one to obtain a parallel view of the courſe of the barometer in two correſponding years of the lunar period of nineteen years, from 1768 to 1797. It were to be wiſhed that the uſe of ſuch charts could be univerſally introduced, and that they might be always to be had ready engraved, ſo that there ſhould be nothing to do but to trace the curve upon them, as is now the caſe at London.

Mr. Howard remarks, and the inſpection of his plate demonſtrates it, that at the approach of the new and full moon the barometrical line experiences a depreſſion, and, on the contrary, it is elevated on that of the quarters. The greateſt depreſſion of the year 1798 correſponds to about twelve hours after the new moon on the 8th of the eleventh (lunar) month, and the greateſt and truly extraordinary elevation

* The firſt part of this ſtatement is correct, except the mention of two curves and an error of the preſs in the original (92 for 98). The latter part contains a miſtake, which the author muſt have committed by writing from memory. The line here mentioned ſerves merely to connect the ſeveral points at which the barometer ſtood at the time of each phaſis, and thus to ſhow the change of level more diſtinctly.—EDIT.

occurred

occurred the 7th of the second (lunar) month at the time of the last quarter *.

The greatest depression of the mercury that had been observed at Paris for forty years happened January 20, 1791, on the day following the full moon.

This coincidence appears to be most regular in fair and moderate weather; and, in general, when the barometer fell during the interval between the new or full moon and the quarter, an evident perturbation in the atmosphere accompanied. I have remarked the same anomalies in the diurnal variations of the barometer; they are regular in settled weather, and are disturbed in changeable.

Mr. Howard draws this general conclusion, that the gravity of the atmosphere as indicated by the barometer may be subject to certain periodical changes, effected by a cause more steady and regular than either change of temperature, currents, or solution and precipitation of water, to which the whole variation has been heretofore attributed.

On comparing the mean height of the barometer at each phase of the moon with the general mean of the year, he found that the mean at the new and full moon was constantly lower, and that at the quarters higher than the general mean. The same result attended the same examination of the ten years observations made at London. The barometer, according to the latter, is depressed at least † four-tenths of an inch (English) while the moon passes from the two quarters to the conjunction and opposition, and rises in the same proportion in her return to the quarters; an effect which the author attributes to the attraction of the sun and moon for the matter of the atmosphere, which ought to have its tides as well as the ocean, but less considerable in proportion to

* It appears that the author has here mistaken the numerical distinction of the months, as if it were applied to the lunar and not to the calendar months, as the chart shows it is. As the elevation here mentioned is, perhaps, almost without a parallel in the records of science, it may not be uninteresting to add a few particulars respecting it, of which we were informed by Mr. Howard. The latter part of the preceding month had been stormy, and solar halos had appeared on two successive days, followed by rain, snow, and hail, amidst which the barometer began rising rapidly on the day before the full moon. This elevation went on for forty-eight hours, with the wind mostly south-west, and blowing very hard. It afterwards apparently went round by north to east, with frosty nights. The highest temperature observed on the day of the maximum was 39°, with a still atmosphere and a fog. The depression which followed began with the wind at south-east, and thence it veered to the westward, most probably by south, as the frost went off with rain.—EDIT.

† In the original it is one-tenth, which appears by reference to the author's statement to be correct.—EDIT.

its leſſer denſity. This had been already proved by M. l'abbé Chiminelle, (*Nouv. Mem. de l'Acad. de Berlin* 1778, p. 45, *de l'Hiſtoire*; *Journal de Phyſique* 1782, *2nde partie*, p. 88; *Mem. ſur la Mar.* tom. i. p. 617.) The barometograph of M. Changeux indicated *daily* tides, and they have alſo been obſerved at Calcutta in Bengal. (*Vide* Philoſophical Magazine, vol. vii p. 363.)

The new form in which I have arranged my regiſters in order to facilitate my examination of C. Lamarck's Theory of Lunar Conſtitutions, (*Journal de Phyſique* 1801, 2d part, p. 222.) has likewiſe ſerved very conveniently to verify the reſults announced by Mr Howard. I have noted, during the ſpace of 34 years and 5 months, (from the 1ſt of January 1768 to the 22d of May 1802,) the aſcending and deſcending direction of the barometer in each of the ſizygies and quarters of the moon which have occurred through that period of time. I here ſtate the total ſum of the elevations and depreſſions of the mercury at each of the phaſes:

For 34½ Years.	New Moon.	1ſt Quar.	Full Moon.	2d Quar.
Sum of elevations	218	296	199	290 times.
—— of depreſſions	281	229	279	106
Differences	63	67	80	84

Theſe reſults of near 35 years obſervations confirm, as will be ſeen, the concluſions drawn by Mr. Howard, both from his obſervations for one year at Plaiſtow, and thoſe made for ten years in the Royal Society's apartments.

It is to be remarked, 1ſt, That the four numbers which expreſs the differences between the elevations and depreſſions are nearly in an exact proportion, ſince $63 : 67 :: 80 : 85\frac{5}{7}$.

2dly, That the two latter phaſes, viz. the full moon and laſt quarter, have more effect than the two firſt.

3dly, I have examined what phaſes of the moon have correſponded to the greateſt and leaſt height of the mercury for each month during ten years, and have obtained the following reſults:

For ten Years.	New Moon.	1ſt Quar.	Full Moon.	2d Quar.
Greateſt elevation occurred at	26	40	26	28 times.
Greateſt depreſſion occurred at	30	34	29	27
Differences	4	6	3	1

The ſcience may be therefore ſaid to have advanced one ſtep further towards perfection on this occaſion; and it is to be hoped that, by redoubling our diligence in multiplying obſervations,

obſervations, and combining them in various ways to obtain their reſults, its progreſs may be ſtill accelerated. The uſeful purpoſes which may be thereby anſwered in philoſophy, agriculture, and medicine, may be properly urged to obſervers as the means of ſupporting their ardour, and indemnifying them for thoſe ſarcaſms and reflections which even ſome learned men have been pleaſed to beſtow upon obſervations of this ſort, together with their authors. (See my Conſiderations on Meteorology, *Journal de Phyſique* 1801, t. lii. p. 388.)

XXVI. *Deſcription of a new Gas-holder.* *By* W. H. Pepys *jun.**

THE combuſtion and deflagration of inflammable ſubſtances, metals, and various compounds in oxygen gas, form ſome of the moſt beautiful and intereſting experiments in modern chemiſtry. The intenſe ſplendour of the liberated light and the variety of its colours aſtoniſh the ſpectator, and become a pleaſing addition to our rational amuſements, while the experiments ſerve at the ſame time to elucidate ſome of the great laws of nature.

Many people, however, have complained that, notwithſtanding the ſimplicity to which the apparatus for ſuch experiments has been reduced, ſomething was ſtill deſirable to enable thoſe who have not had many opportunities of acquiring habits of experimenting to enjoy this intereſting ſcience without the inconvenience of being obliged to uſe a pneumatic ciſtern for the purpoſe of transferring the gas. To accommodate ſome friends of this deſcription, I contrived a gas-holder, which not only obviates the above inconvenience, but is capable of being employed to tranſport the gas from place to place, and to preſerve it from being contaminated, and of being uſed for experiments with the blowpipe.

This apparatus is in ſome reſpects ſimilar to that recommended by Mr. Watt. A ſmall circular ciſtern is added at top, which is connected with the gas-holder by means of two pipes furniſhed with cocks. It has alſo a braſs cock on the ſide, and a glaſs gage or regiſter tube ſhowing the quantity of included gas by the level of the water. The following is a deſcription of the different parts:

The gas-holder G (Plate IV.) may contain from two to ten gallons.

R, the regiſter tube; the ends of which are cemented into

* Communicated by the Author.

two tin ſockets by corks at the top and the bottom of the gas-holder, into which it opens at both ends: of courſe the level of the water in the apparatus will always be ſeen in the tube, and conſequently that of the gas.

C, the circular ciſtern, with its two cocks and pipes, marked 1 and 2.

Ck, a braſs cock on the ſide, with a ſcrew, to which bladders or a blowpipe may be attached.

O, an opening into the gas-holder, in which a pipe is ſoldered at ſuch an angle, that when all the uppermoſt cocks are ſhut no water can poſſibly eſcape. But when a conducting-pipe, from a retort or other apparatus generating gas, is introduced into this opening, then, as the gas paſſes up into the gas-holder, an equal quantity of water will be diſcharged at O into any veſſel fit to receive it.

S*p*, a ſpout on the ſide of the ciſtern to enable the operator to add water even when the receiver fills its whole area.

H H, handles to lift the gas-holder by.

R*c*, a glaſs deflagrating receiver ſtanding in the ciſtern.

A, its adopting cork and cock.

S, a watch ſpring in a ſlit wire prepared for combuſtion. The wire paſſes through a cork.

D, a deflagrating diſh of iron for ſulphur, phoſphorus, bark of charcoal, ſugar, camphor, &c.

B, a blowpipe, with a gum elaſtic tube E, capable of joining the cock *Ck*.

To make uſe of this apparatus, firſt fill the gas-holder with water, by cloſing the opening O with a cork, and alſo the cock *Ck*, and keeping the circular ciſtern full of water, while the cocks 1 and 2 are both open. The air is driven out of the gas-holder through the cock 1, by the water deſcending into it by the cock 2. When full, the water in the regiſter will be on a level with the top of the gas-holder. Then ſhut the cocks 1 and 2. You may now remove the cork from the opening O, which is then prepared to receive the conducting-pipe from any apparatus from which the gas is generating. As the gas is delivered the water eſcapes, and ſhould be caught in any convenient veſſel. The regiſter will then ſhow the quantity received: when full, cloſe the opening O with a cork wrapped in leather, which prevents the communication with the atmoſphere. It may now be eaſily removed or conveyed where it is wanted.

When it is required to fill a glaſs receiver, as R*c*, with the gas, having previouſly filled the circular ciſtern with water, place it in the ciſtern, put in the adopting cork A, and, with the mouth applied to the cock, exhauſt the receiver, in which the water will riſe till full. Then cloſe the cock

cock A, and open the two cocks 1 and 2, and the gas will aſcend into the receiver, while the water will take its place in the gas-holder. The ſubſtances to be experimented upon ſhould be mounted with wires paſſing through corks covered with wetted leather, like the watch-ſpring S, or the deflagrating pan D, in which the ſubſtances intended to be expoſed to the action of the gas muſt be ignited.

It is not here neceſſary to enter into a particular account of each proceſs, as they are in general well known even to the young experimentaliſt. It may be neceſſary, however, to add as a caution—that, after the deflagration, the gas-holder and receiver ſhould be removed into an open place or under the chimney, that the acid gas, or any other injurious air, may be ſufficiently changed before the receiver is again exhauſted by the mouth.

When the blowpipe is uſed it ſhould with its elaſtic pipe be ſcrewed on to the cock *Ck*; the ciſtern ſhould be kept full by reverſing a large receiver of water over it, or any other ſimple method, and the cock 2, only opened for the admiſſion of water.

Bladders mounted with cocks may be filled with gas by firſt emptying them of atmoſpheric air, then ſcrewing them to the cock *Ck*, filling the ciſtern with water, and opening the cock 2. In all theſe inſtances the quantity uſed may be aſcertained from the regiſter, which has a ſcale of pints or cubic inches attached to it.

The numerous experiments in which the gaſes, particularly oxygen, are uſed, will, I conceive, be a ſufficient apology for troubling the readers of your valuable and intereſting Magazine with this trifle, which I have really found uſeful in the laboratory.

XXVII. *Experiments on Charcoal.* *By* CLEMENT *and* DESORMES.

[Concluded from p. 73.]

SECOND METHOD.

Action of the Sulphur.

HAD we begun our labour as we have related, we ſhould probably have been ſatisfied with the proofs before eſtabliſhed, that there exiſts no hydrogen in charcoal; and we ſhould not have had recourſe to the action of ſulphur. But an experiment having made known to us a particular combination of charcoal and ſulphur, we reſolved to continue our labours.

We

We ſhall here obſerve, that as this combination appeared to us to be the liquid hydrogenated ſulphur of Scheele, mentioned in the memoir of C. Berthollet on ſulphurated hydrogen, we were ſtrongly inclined to acknowledge the preſence of hydrogen in charcoal; and we did not change our opinion till after an examination on a large ſcale, and the moſt deciſive experiments.

Sulphur and charcoal combine at a high temperature, and probably in different proportions. One of theſe combinations is liquid at the uſual temperature and preſſure of the atmoſphere. It is this combination in particular which we ſhall examine.

It is tranſparent and colourleſs when pure, but in general of a greeniſh yellow colour; has a diſagreeable odour ſomewhat pungent, but not inſipid like that of ſulphurated hydrogen: it produces on the ſkin a conſiderable degree of cold, and evaporates as ſpeedily as ether, without any reſiduum if colourleſs, and leaving ſulphur behind it if yellow. Its ſavour is at firſt cool, but afterwards exceedingly pungent like that of ether.

It is heavier than water, and keeps at the bottom of that fluid without mixing with it, in the ſame manner as a heavy oil.

As this combination reſults from the union of ſulphur and charcoal, it may with propriety be called *carburated ſulphur*.

Preparation of carburated Sulphur.

This ſubſtance is obtained by making ſulphur paſs through an ignited porcelain tube in which charcoal in fragments and in powder has been previouſly heated. It muſt be heaped up a little in order that the ſulphur in vapours may be obliged to come into full contact with it.

To operate exactly, we adjuſted to one extremity of the porcelain tube which contained the charcoal a long glaſs tube, pretty large, containing a file of ſmall ſticks of ſulphur which could be ſucceſſively puſhed into the porcelain tube by an iron ſpike paſſing through a cork with which the tube was cloſed. At the other extremity was an adaptor of glaſs terminated by a bent tube immerſed in a glaſs flaſk which communicated with the pneumatic tub.

With a little care, an apparatus of this kind may be eaſily conſtructed ſo as to loſe nothing.

Before the ſulphur is introduced, all the gas the charcoal is capable of giving by heat muſt be ſuffered to eſcape: the ſulphur muſt be introduced ſlowly. When it acts on the charcoal, a yellowiſh liquid, having the appearance of an oil, is ſeen to condenſe itſelf in the adaptor. By continuing the heat

heat it evaporates, and is condenſed in the water of the flaſk; it traverſes it in globules which in appearance do not diſſolve, and which are collected at the bottom.

The complete ſucceſs of this experiment is very uncertain. The regular manner in which ſulphur acts when heated in cloſe veſſels, is one of the principal obſtacles. It is well known that if ſuddenly expoſed to a great heat inſtead of being volatilized, it becomes fixed in ſome meaſure, and forms a kind of paſte. It often happens that ſulphur expoſed to a ſtrong heat in a porcelain tube is not volatilized, and that no carburated ſulphur is formed. In that caſe more ſulphur is introduced, to bring the other to ſuch a low temperature that the whole may be volatilized; but it then paſſes too rapidly over the charcoal to be united with it, and the ſublimated ſulphur, by condenſing in the adaptor, often makes it burſt. It is much better to urge the ſulphur very ſlowly, and, in particular, to incline the tube towards the adaptor to make the ſulphur run upon the charcoal.

During the production of the carburated ſulphur, no gas is diſengaged. The air in the veſſels only receives an expanſion by its mixture with the carburated ſulphur, which is exceedingly volatile, and a little which has become inflammable eſcapes.

Notwithſtanding the difficulty of ſucceeding in this experiment, we made one in which ten grammes of charcoal entirely vaniſhed. It appeared to us that it formed nearly one-third of the combination. When any bits of charcoal remain they are viſibly corroded and of a paler black colour than before, being ſubjected to the action of the ſulphur.

When more ſulphur than is neceſſary for the production of liquid carburated ſulphur paſſes on the ignited charcoal, the reſult is a ſolid, which cryſtallizes in the adaptor. Theſe cryſtals ſeem to reſemble thoſe of ſulphur, but they contain charcoal, for they evidently leave ſome of it after their combuſtion in the open air. This ſolid carburated ſulphur may contain a little of the liquid, and in that caſe it forms a paſte, which in the air ſoon loſes its odour and its conſiſtence.

It appears that to produce a combination of ſulphur and charcoal they muſt be both exceedingly warm; for, by heating in a retort a mixture of ſulphur and charcoal well united, a little gas only is obtained of a bad odour, inſoluble in water, and which Scheele called *inſoluble hepatic gas*.

We burnt a gas nearly ſimilar, which may be procured in large quantity, by means we ſhall deſcribe hereafter; and we had for product a great deal of carbonic acid and ſulphurous acid, but apparently no water.

Whether this was a gaſeous combination of charcoal and ſulphur, or gaſeous oxide of carbon, holding in combination ſulphur, we will not venture to determine. Oxygenated muriatic acid gas, however, when brought into contact with this ſubſtance, the nature of which is not perfectly known to us, deſtroys it almoſt entirely, and ſulphur is depoſited, which is the caſe alſo when carburated ſulphur is evaporated in the air.

Beautiful carburated ſulphur may be obtained, but in ſmall quantity and after long expoſure to the action of the fire, by heating ſulphuret of antimony with charcoal. Sulphuret of mercury treated in the ſame manner gives a very ſmall quantity, but thoſe of copper and iron do not produce a ſingle atom.

When ſulphuret of ſtrontian is prepared by ſulphate and charcoal, if there be a great deal of the latter, carbonic acid is obtained; carbonous gas, mixed probably with hydrogen; and, in the laſt place, a fetid gas, partly ſoluble and partly inſoluble in water. This ſecond portion ſeems to us to be the gas above mentioned. In this experiment a very large quantity of ſtrontian was diſengaged: the union of the ſulphur with the charcoal is the cauſe, perhaps, which makes it abandon its baſe.

By expoſing a mixture of charcoal and ſulphuret of potaſh, carefully made to a ſtrong heat, there is obtained a prodigious quantity of this gas, which, we have already ſaid, may be only gaſeous carburet of ſulphur, and which by combuſtion gives a great deal of ſulphurous acid and carbonic acid.

The diſtillation of calcined ſulphate of alumine and charcoal gave alſo a little of this gas. Sulphuret of lime, treated in the ſame manner, gave none of it.

By diſtilling wax with ſulphur a great deal of ſulphurated hydrogen is obtained, and at laſt liquid carburet of ſulphur, but ſtained by the undecompoſed oil and an empyreumatic oil.

Examination of the Liquid Carburet of Sulphur.

We have already obſerved that on the firſt view we ſuſpected this ſubſtance to be the hydrogenated ſulphur of Scheele, but the following experiments ſhowed this opinion to be falſe.

C. Berthollet aſſigns to this ſubſtance the property of ſuffering ſulphurated hydrogen to be diſengaged, and of depoſiting ſulphur. But the combination which we call *carburated ſulphur* does not contain ſulphurated hydrogen.

1ſt, If a quantity of this ſubſtance very limpid be put under

under a bell filled with water under a receiver, and if the air be exhauſted till the remainder forms an equilibrium with a column of mercury of about 20 or 25 centimetres at the mean temperature, the carburated ſulphur is then ſeen to aſſume the ſtate of gas; it riſes in large bubbles through the water without being diſſolved in it: and, if the preſſure be reſtored, the gas is immediately condenſed, and reappears under a liquid form.

Sulphurated hydrogen which traverſes water at the ſame preſſure, diſſolves in it; water ſaturated with ſulphurated hydrogen, at the preſſure of the atmoſphere parts with but a very ſmall quantity of it, when the preſſure is reduced to a fourth. The gas then produced by carburated ſulphur is not ſulphurated hydrogen.

2d, If carburated ſulphur be introduced into a barometric tube, in which the mercury maintains itſelf at 76 centimetres, it immediately falls to 50 centimetres. The temperature being 12·5 * degrees, if the tube be immerſed in a mercurial tub, the whole gas which made the mercury in the barometer fall, becomes condenſed, and the tube is filled with mercury. This gas, then, is not ſulphurated hydrogen, for without the contact of an abſorbent the latter would have remained gaſeous.

This experiment aſcertains nearly the elaſtic force of carburated ſulphur at the mean temperature. That, indeed, introduced into the barometer by making the mercury deſcend to 50 centimetres, ſupplies, by its elaſticity, the place of a column of 26 centimetres, which is the meaſure of it. That of ether at the ſame temperature is ſomewhat greater.

If the preſſure of the atmoſphere were only 26 centimetres, no carburated ſulphur would exiſt but in the gaſeous ſtate.

3d, If liquid carburated ſulphur be put into a veſſel with acetite of lead over it, and if this veſſel be expoſed in a complete vacuum, the carburated ſulphur will be ſeen to aſſume the elaſtic ſtate, and to traverſe the acetite of lead without blackening it, which ſulphurated hydrogen would not fail to do. If the carburated ſulphur be ſtirred with a ſolution of lead, it at length becomes turbid, and aſſumes a brown and not a black colour.

We tried, but in vain, to combine ſulphur with ſulphurated hydrogen to obtain hydrogenated ſulphur; we, however, made this gas paſs with ſulphur in vapours into a warm receiver. There was no very ſenſible action; the ſulphur only retained the odour of the gas, but was no leſs ſolid.

* We ſuppoſe of Reaumur's thermometer, = 62° Fahr.—Edit.

By

By pouring, according to the advice of C. Berthollet, a little of hydrogenated ſulphur into an acid, we obtained a precipitate of ſulphur of an oily appearance, but ſimilar to a paſte, and which ſoon loſt all the ſulphurated hydrogen gas it contained: it then became ſolid like common ſulphur, which is very different from carburated ſulphur, as the latter has no ſmell of ſulphurated hydrogen, and when pure ſcarcely leaves any reſiduum.

Theſe experiments ſeem to us ſufficiently deciſive to conclude that carburated ſulphur contains no ſulphurated hydrogen.

The ſpecific gravity of this liquid muſt vary; we found it once to be 13, that of water being ten.

Carburated ſulphur inflames with great facility. It emits a ſtrong odour of ſulphurous acid; depoſits a little ſulphur, which then burns; and there remains black combuſtible charcoal as uſual.

This body, on paſſing into an ignited glaſs tube, experiences no ſenſible alteration.

It evaporates at the uſual temperature, and greatly increaſes the volume of the air—nearly as much as ether. It exerciſes the ſame action on oxygen, azotic, hydrogen, and nitrous gas. It renders them all inflammable, but does not ſeem to produce on them any particular alteration *.

The oxygen which holds carburated ſulphur in gas, detonates with a prodigious force—incomparably greater than that produced with hydrogen. We hoped to be able to employ this method to doſe the conſtituent principles of this body, but we did not think it prudent to operate this detonation in cloſe veſſels. Theſe veſſels ought to be exceedingly ſtrong, and even then, if of glaſs, the experiment would be attended with danger.

The air which has diſſolved carburated ſulphur ſuffers it to burn quietly.

As we have mentioned the differences between carburated ſulphur and hydrogenated ſulphur, we muſt not conceal a reſemblance which we have found between them.

Nitrous gas which holds in ſolution carburated ſulphur gaſified by it, is inflammable like the other gaſes; but the colour and beauty of its flame are peculiar, they can be compared only to that of zinc, which burns with rapidity.

* This evaporation of carburated ſulphur takes place exactly in the ſame manner as that of ether; it is proportional to the volume of the gas, and does not depend on the nature of it: this affords a new reaſon for believing it probable that the caſe is the ſame with the evaporation of water.

Sulphurated

Sulphurated hydrogen mixed with nitrous gas produces a ſimilar effect.

This is the only experiment in which carburated ſulphur did not exhibit the ſame phænomena as if it contained ſulphurated hydrogen; and this fact cannot certainly deſtroy the opinion which we formed, in conſequence of all thoſe we have compared and repeated, in order to prove the difference of theſe two bodies: beſides, it is poſſible that the colour and vivacity of the flame may have ariſen from the ſulphur, which is a principle of both.

If a piece of rag be dipped in liquid carburated ſulphur and wrapped round the bulb of a thermometer, and if the evaporation be aſſiſted by the wind of a bellows, it will make the thermometer deſcend to the freezing at leaſt, that is to ſay, lower than ether under the ſame circumſtances.

This ſubſtance unites with phoſphorus, and diſſolves with great facility; but this ſolution is not more inflammable than phoſphorus alone.

It unites alſo to a ſmall quantity of ſulphur without changing its ſtate, only it becomes more coloured.

It ſeems to have no action on charcoal.

The water in which carburated ſulphur condenſes during its preparation acquires a greeniſh-yellow colour, which in the courſe of time becomes white and milky. At firſt, this ſolution precipitates lead of a reddiſh-brown colour, and then black, as ſulphurated hydrogen does; and at length, after a conſiderable time, white, like the ſulphuric acid. It is to be preſumed that the water in this caſe is decompoſed. If this action of carburated ſulphur on water is not very viſible, it is the more ſo when the water contains a fixed alkali; the union takes place with difficulty even by heat; the carburated ſulphur traverſes the alkaline ſolution in vapours without uniting ſpeedily with it: however, if heated in a veſſel almoſt cloſe, in order to prevent the eſcape of the carburated ſulphur, it diſſolves almoſt entirely, and nothing remains but a little charcoal in the form of a black powder. This ſolution, when recently made is of a dark amber colour, and diſengages only a very little ſulphurated hydrogen by the addition of an acid; but at the end of ſome time, and particularly when evaporated, there is formed a great deal of ſulphurated hydrogen and carbonic acid. The latter is ſo abundant that the alkali cryſtallizes very eaſily. This phænomenon takes place in particular with ſoda. The reſt of the ſolution is hydrogenated ſulphuret, which precipitates ſolutions of lead of a beautiful red colour. This precipitate, which becomes browner in the air,

air, is a hydrofulphurated oxide of lead. Carburated fulphur unites alfo with ammonia, but the alkali does not become cryftallizable: the whole is volatilized by heat.

The nitric, muriatic, and fulphuric acids do not attack carburated fulphur cold. When warm, the nitric acid burns a part of it.

Liquid fulphurous acid does not attack it fenfibly. The cafe is the fame with the gafeous. Carburated fulphur is volatilized in it as in the other gafes, and there is no precipitation of fulphur; which would not fail to be the cafe if there were fulphurated hydrogen.

Liquid oxygenated muriatic acid burns it flowly, and it appears that it attacks the charcoal rather than the fulphur, for the latter becomes folid. This will probably afford the means of analyfing that fubftance when it becomes neceffary to afcertain exactly its conftituent principles.

Carburated fulphur diffolves very well in olive oil, but better when hot than when cold: it depofits a little charcoal, and cryftallizes regularly and very foon by cooling.

Alcohol makes it pafs almoft inftantaneoufly to the foft ftate.

A portion of that which is diffolved is precipitated by the water, and ftill retains charcoal.

Ether mixed with carburated fulphur makes it cryftallize regularly and immediately another part is diffolved. A cryftallization better determined is obtained almoft as fpeedily by the action of a warm folution of potafh placed in an open veffel, where the too elaftic carburated fulphur has an opportunity of efcaping. The cryftals, the moleculæ of which we might almoft fay we faw arranged, are elongated octaedra, pretty large, very regular and complete, becaufe they are formed in the middle of the liquor.

It might have been believed that the charcoal united itfelf to the phofphorus and gave birth to a new compound; but here, as in many other circumftances, analogy is in fault, and we were not able to obtain, by fimilar means, this combination.

This account of our experiments is already too long, if its direct utility be confidered. It is very probable that when we found this carburated fulphur, had we not fuppofed it to poffefs fome ufeful principles, we fhould have paid lefs attention to it. But, fince, we were not fo fortunate as to find any other effects produced by it than that of occafioning a confiderable degree of headach, and difpofing us to fleep, by infecting the air which we infpired. The labour, however, is done,

done, and we know that the combination of charcoal and ſulphur preſents nothing very intereſting *. It is, however, poſſible that in abler hands this ſubſtance may be the mean of leading to new diſcoveries.

CONCLUSIONS.

1ſt, The nature of the gas has no influence on the evaporation of the liquids; that is to ſay, the reſpective quantities of ether, alcohol, carburated ſulphur, and very probably water, evaporate equally in equal volumes of oxygen gas, hydrogen, azote, carbonic acid, and atmoſpheric air, when the temperature, preſſure, and other circumſtances are ſimilar.

2d, Charcoal of whatever kind it may be gives no water in burning, and requires the ſame quantity of oxygen; it therefore contains no hydrogen, and if there be oxygen it always contains of it the ſame, ſince the carbonic acid produced is always the ſame.

3d, Sulphur and charcoal can combine at a high temperature. The reſult is, 1ſt, a tranſparent and highly volatile liquid; 2d, a cryſtallizable ſolid, and, perhaps, a gas permanent at the uſual ſtate of the atmoſphere: in theſe combinations no trace of hydrogen can be obſerved.

4th, The gaſeous oxide of carbon, obtained by dried charcoal and carbonic acid, or other analogous means, does not contain hydrogen. It is a ſimple combination inflammable *per ſe*.

The *Journal de Phyſique et de Chimie*, publiſhed by C. Van Mons for the month of Pluvioſe laſt, contains a memoir, by the Dutch chemiſts, on the ſuppoſed gaſeous oxide of carbon.

It contains experiments which to us do not ſeem concluſive. Theſe chemiſts did not even obſerve the preſence of oxygen in that gas. Had they doſed the quantities on which they operated, they would have ſeen that the carbonic acid in paſſing on the charcoal almoſt entirely diſappears, and ſhows itſelf again under an inflammable form. It formed part then of this new gas, which then became mere carbonated hydrogen: it is very probable that what they obtained was united with hydrogen only, becauſe the charcoal had not been ſufficiently heated and well protected from the action of humidity.

Of this we have a proof in the experiment in which theſe chemiſts, by making azote paſs upon the charcoal inſtead of carbonic acid, rendered it inflammable. We long ago made this experiment with charcoal well burnt, and the azote acquired no inflammability.

* For our part, we think the ſubject extremely intereſting.—EDIT.

The ſame chemiſts, to prove their aſſertion, ſtate, that copper does not decompoſe the carbonic acid, as iron does in the experiment of Cruickſhank. But it may be ſaid in anſwer, that as the former metal does not decompoſe the water, it may not have the property of decompoſing carbonic acid.

In a word, the combination of inflammable gas with ſulphur, obtained by the Dutch chemiſts, and which they took to be ſulphurated hydrogen, was only a mixture of that gas with the gaſeous oxide of carbon a little ſulphurated, of which we have already ſpoken.

Carburated ſulphur is not a diſcovery entirely new: ſince our labour we have learned that it had been announced in ſome work or other before.

XXVIII. *An Eſſay on Longevity.* By Sir John Sinclair, *Bart.*

Introduction.

THE means of preſerving health, and of attaining great age, are ſubjects which ſeem to be well entitled to the peculiar attention of every thinking man. In regard to the former, there is no queſtion: the pleaſure that ariſes from the poſſeſſion of health, and the diſtreſs which ſickneſs occaſions, are perpetual mementos that health cannot be neglected. But as to the latter, the propriety of aſpiring to long life has been doubted; and it is ſaid, after a perſon has lived for 50 or 60 years, and has fulfilled his duties as a man, that he had better retire to make way for others, and that the ſooner he quits theſe ſublunary ſcenes the better. Such ſentiments, however, ought not to be indulged. If perſons lived only for themſelves, and for the gratification of their own paſſions, and to promote their own intereſts alone, this might be the caſe. But if we live, as we ought to do, to promote the happineſs of others as well as our own, and if by living long we can be of more ſervice, from the knowledge which greater experience and longer obſervation muſt neceſſarily furniſh, the reſult is, that we ought to live as long as we have health and ſtrength to perform good actions to others, and that the power of doing good ought to be the proper limit by which our wiſhes for exiſtence ought to be bounded: nor ought it to be omitted, that there is an evident and neceſſary connection between good health and longevity, as it is impoſſible to poſſeſs the one without its contributing to the enjoyment of the other.

In ſketching out ſome obſervations on this important ſubject,

ject, it is my intention to ſtate, 1. The circumſtances which tend to promote longevity. 2. The rules which have been adopted by thoſe who have attained great age. 3. The peculiar deſcription of countries moſt remarkable for long life. And, 4. To add ſome tables of longevity and the duration of human life.

I. *Circumſtances tending to promote Longevity.*

The circumſtances tending to promote longevity may be conſidered under the following general heads:—1. Climate. 2. Form of the individual. 3. Parentage. 4. Natural diſpoſition. 5. Situation in life. 6. Profeſſions. 7. Exerciſe or labour. 8. Connubial connections. 9. Sex. And, 10. Renewal of age.

1. *Climate.*—In the firſt place, climate ſeems to be of conſiderable importance; and it may be laid down as a general rule, that the moderate, or even the coldeſt climates, are the moſt favourable to long life. Heat ſeems to relax and enfeeble, cold to ſtrengthen and brace, the human frame. The diet alſo of hot countries is not ſo nouriſhing as that of cold *; and there is in general a greater diſpoſition and greater opportunities to indulge in various exceſſes in the former than in the latter. But if the climate be cool, a rainy atmoſphere ſeems to be leſs unfavourable to longevity than could well be imagined; for Ireland, which is a wet country, boaſts of a great number of old people. And a very large proportion of the aged who have lived in England and Scotland, have reſided in the weſtern, and, conſequently, the rannieſt counties in the iſland †.

2. *Form.*—The next circumſtance to be conſidered is, the form and ſize of the individual. It is generally admitted that perſons of a compact ſhape, and of a moderate ſtature, are the moſt likely to live long. Height often originates from the diſproportioned growth of ſome particular part of the body, which neceſſarily has a tendency to engender weakneſs and diſeaſe. Tall perſons alſo are apt to acquire a habit of ſtooping, which contracts the cheſt, and is a great enemy to free reſpiration; whereas the ſhort-ſized find little difficulty in keeping themſelves erect, and are naturally much more

* In cold countries they live more upon animal, in hot countries upon vegetable, food, and fruits. A judicious mixture of both is the beſt plan to purſue; but, of the two, animal food is the moſt nouriſhing.

† Moiſture, it would appear, is not prejudicial to health, if it does not affect the purity of the air. Even ſtagnated water, if in peat bogs or moraſſes, is not unwholeſome, as the water, by the aſtringency of the peat, is prevented from becoming putrid. Lincolnſhire alſo, and ſeveral of the marſhy counties of England, can produce a number of inſtances of great age, but probably they were from the more elevated parts of theſe diſtricts.

active, by which the animal functions are retained in a ſtate of much greater perfection. The only diſadvantage attending a ſhort ſtature is, that it is frequently accompanied with corpulence, which is rather unfavourable to long life.

3. *Parentage.*—Being born of healthy parents, and exempted from hereditary diſeaſe, are circumſtances evidently favourable to longevity. A puny frame, like Cornaro's, may, by the greateſt care and anxiety, be preſerved in exiſtence; but thoſe who inherit health and ſtrength, and are born with robuſt conſtitutions, can alone expect not only to live long, but to enjoy the pleaſures and comforts of life, whilſt they continue to poſſeſs it.

4. *Natural diſpoſition.*—Longevity alſo ſeems to depend much upon good temper, mixed at the ſame time with a cheerfulneſs of diſpoſition or good ſpirits *. Neither the iraſcible, nor thoſe who, from deſpondency, ſink under the croſſes of life, can expect to live long. Even thoſe who ſuffer their ſtrength and ſpirits to be exhauſted by ſevere ſtudy, or other mental exertions, ſeldom reach great age. In the long liſt of 1712 perſons who lived about a century, Fontenelle (who did not quite reach 100 years,) is the only author of any note; and his great age is aſcribed to the tranquil eaſe of his temper, and that livelineſs of ſpirits for which he was much diſtinguiſhed; for he retained to the laſt *the youth of old age*, as the French happily expreſs it.

5. *Situation in life.*—It is commonly obſerved, "that it is not the rich and great, not thoſe who depend on medicines, who become old, but ſuch as uſe much exerciſe, are expoſed to the freſh air, and whoſe food is plain and moderate †." And it is certain that perſons of that deſcription, in general, ſtand the beſt chance of living long. At the ſame time, though inſtances of old age in great and noble perſonages are not often to be met with, yet they may be as many, *in proportion to the ſmaller number of ſuch perſons*, as thoſe in the lower but more numerous claſſes of ſociety. Nor is there any thing inconſiſtent in power, rank, or wealth, being accompanied with a long period of exiſtence, provided other circumſtances are favourable to longevity.

6. *Profeſſions.*—In the next place, it is evident that long life muſt depend much on the manner in which the individual is employed. Unhealthy occupations generally become fatal. Yet Peter Prin, a glaſs-blower, is ſaid to have attained the great age of 101; and John Tyler, a miner at Leadhills,

* Hence the great age to which many of the French nobility lived, particularly before the regency of Orleans.

† See Eaſton on Human Longevity, Introduction, p. xi.

in

in Scotland, is ſuppoſed to have reached even 132 years*. His age, indeed, could not be proved by direct, but it reſts on very ſtrong circumſtantial, evidence; and a perſon of the moſt undoubted authority (Dr. Walker, profeſſor of natural hiſtory in the univerſity of Edinburgh,) informs me, "that in his muſcles, joints, and in his whole conformation and aſpect, he wore the appearance of more remote antiquity than he had ever ſeen in any human creature." But on the whole, farmers, gardeners, and labourers in the country, are in general the longeſt lived. Foot ſoldiers alſo, who have ſurvived the dangers of war, are remarkable for long life. They are generally ſtout and vigorous men, and the regularity to which ſurviving ſoldiers muſt have accuſtomed themſelves, whilſt the careleſs and diſorderly drop off, the erect poſture to which they have been trained, and being of courſe men well formed by nature, and habituated to march and walk well, (which familiarizes them to a natural and healthy exerciſe,) all combine in their favour.

7. *Exerciſe or labour.*—It is alſo proper to remark, that not only moderate exerciſe, but even labour, if not too ſevere, contributes to good health and old age. In many inſtances, perſons have worked at threſhing, and other laborious occupations, expoſed to a current of freſh air, after they had paſſed beyond the age of 100; and, if accuſtomed to them, they do not appear to have ſuffered any inconvenience from ſuch exertions.

8. *Connubial connections.*—Nor ought it to be omitted, that a large proportion of the long-lived have preferred a married to a ſingle ſtate, and in general have left behind them a numerous family. Whether a life of celibacy occaſions diſeaſe, or leads to irregularity, or ſours the temper, or to whatever other cauſe it ought to be attributed, may be a ſubject of diſpute, but it is certain that the number of ſingle perſons who live long bear no proportion to the married †.

9. *Sex.*—Further, though a greater number of males are born than of females, at leaſt in European countries, yet there is reaſon to believe that of the two ſexes, women reach old age in the greateſt proportion. For this various cauſes may be aſſigned, as the greater regularity and temperance of their mode of living, their being leſs expoſed to dangers and

* It is ſaid that neither of theſe inſtances ought much to be wondered at, as a glaſs-blower is conſtantly expoſed to freſh and dry air, and the labour of miners under ground is not for many hours, and they generally reſide in hilly diſtricts.

† This applies to both ſexes, in particular to the male. Dr. Ruſh, of Philadelphia, aſſerts, that he never ſaw but one unmarried man exceed fourſcore years.

hardſhips, leſs ſubject to violent agitations, and generally endowed with more cheerfulneſs and gentleneſs of diſpoſition.

10. *Renewal of youth.*—In the laſt place, among the ſymptoms of longevity, none is more ſtriking than when nature ſeems to renew itſelf, by producing, even in old age, new teeth, new hair, &c.; but the inſtances of this are extremely rare.

II. *Rules tending to promote long Life.*

We ſhall now proceed to ſtate ſuch rules as have been followed by thoſe who have attained great age, as they may furniſh ſome hints that may be ſerviceable to others.

The plan laid down by the celebrated Cornaro is well known, and the abſtemious manner in which he lived has often been recommended to the imitation of others; but I queſtion much whether many would wiſh to lead the ſame life for the ſake of mere exiſtence. Life is no longer deſirable than whilſt it can be enjoyed with ſome degree of ſatisfaction, and it is of little conſequence, if a perſon merely vegetates, whether he lives or not.

Without entering therefore into various particulars, fitter for the diſcuſſions of experimental philoſophy than for real life, (as weighing the food taken, &c. &c.) we ſhall proceed to mention the rules which have been found the moſt effectual, and which are the moſt likely to be carried into practice. They may be claſſed under the following heads:—1. Food. 2. Clothing. 3. Habitation. 4. Labour or exerciſe. 5. Habits or cuſtoms. 6. Medicine. And, 7. Diſpoſition of mind.

1. *Diet.*—The importance of wholeſome food for the preſervation of health and long life, and the avoiding of exceſs, whether in eating or drinking, need not be dwelt upon. Some inſtances, indeed, are mentioned of perſons who have continued to commit exceſſes and have lived long; but theſe are to be conſidered in no other light than as exceptions from a general rule; and it may reaſonably be contended, that if ſuch perſons lived to a great age notwithſtanding their intemperance, they would have lived much longer had they followed a different courſe.

2. *Clothing.*—It is equally unneceſſary to detail at any length the neceſſity of warm clothing, more eſpecially in advanced life, and during the cold ſeaſons, as the beſt mode of preventing a number of diſeaſes to which old men are particularly expoſed, and which by no other means can be avoided.

3. *Habitation.*—The health of every individual muſt greatly depend on the place where he reſides, and the nature of the houſe which he inhabits; and as it has frequently been remarked that the greateſt number of old people die in winter, and

and that many individuals, in a weak and conſumptive ſtate, are obliged to fly to warmer climates as the only means of ſafety, it has thence occurred to Dr. Pearſon that it would be of ſervice both to the aged and to the conſumptive to have houſes erected of ſuch a peculiar conſtruction that the air could always be preſerved, not only pure, but nearly of the ſame, and of rather an elevated temperature, ſo that the invalids who reſided in them ſhould never be affected by the viciſſitudes of the ſeaſons. Such an idea, it muſt be admitted, cannot be a general remedy or reſource; but it is well entitled to the attention of thoſe who are in affluent circumſtances, by ſome of whom, it is to be hoped, an hoſpital for the aged and the conſumptive will be erected, and the experiment fairly tried, both for their own ſakes and for that of human nature in general.

4. *Exerciſe and labour.*—That either exerciſe or moderate labour is neceſſary even to aged perſons, for the purpoſe of preſerving the human frame in order, can hardly be queſtioned, provided any great exertion is avoided, than which nothing is more likely to deſtroy the ſprings of life, particularly when theſe become feeble. Travelling in moderation alſo, from the change of air and ſcene, has been found of great uſe.

5. *Habits and cuſtoms.*—In the next place, good health, and conſequently longevity, depends much on perſonal cleanlineſs, and a variety of habits and cuſtoms, or minute attentions, which it is impoſſible here to diſcuſs. It were much to be wiſhed that ſome author would undertake the trouble of collecting the reſult of general experience upon that ſubject, and would point out thoſe habits which, taken ſingly, appear very trifling, yet when combined there is every reaſon to believe that much additional health and comfort would ariſe from their obſervance.

6. *Medicine.*—It is a common ſaying, that every man, after the age of forty, ſhould be his own phyſician. This ſeems, however, to be a dangerous maxim. The greateſt phyſicians, when they are ſick, ſeldom venture to preſcribe for themſelves, but generally rely on the advice of their medical friends. Perſons who pretend to be their own phyſicians are generally much addicted to quackery, than which nothing can be more injurious to the conſtitution. It is eſſential to health that medicines ſhould never be taken but when neceſſary, and never without the beſt advice, in regard to the commencement, which ought not to be too long delayed, otherwiſe much benefit cannot be expected from them, and alſo with reſpect to nature or ſort, quantity, and continuance.

At preſent, the powers of phyſic, it is generally acknowledged, are extremely bounded. The medical art, however, is probably ſtill in its infancy, and it is impoſſible yet to ſay to what perfection it may reach, not only in conſequence of the new improvements which chemiſtry daily furniſhes, but alſo of thoſe which may be made by the diſcovery of new and valuable plants in countries either already known or hitherto unexplored, and indeed the new uſes to which old medicinal plants may be applied. Perhaps ſuch diſcoveries will be much accelerated, when, inſtead of being left to the zeal and induſtry of individuals, they ſhall meet with that public encouragement and protection to which they are ſo peculiarly well entitled.

7. *Diſpoſition of mind.*—In the laſt place, nothing is more conducive to longevity than to preſerve equanimity and good ſpirits, and not to ſink under the diſappointments of life, to which all, but particularly the old, are neceſſarily ſubjected. Indeed this is a point which cannot be too much inculcated; for experience ſufficiently demonſtrates that many periſh from deſpondency, who, if they had preſerved their ſpirit and vigour of mind, might have ſurvived many years longer.

III. *Countries remarkable for Longevity.*

The countries the moſt remarkable for long life are thoſe of a hilly nature. We are informed by Pallas that the inhabitants of the mountainous diſtricts of the province of Iſeſk, in the northern parts of Siberia, live to a great age; that people of 100 years are very common, and that he ſaw an invalid ſoldier aged 120. The inhabitants of the plains in their neighbourhood are, at the ſame time, by no means ſo healthy or ſo long lived. Buffon places the mountainous diſtricts of Scotland at the head of a liſt containing thoſe parts of Europe the moſt diſtinguiſhed for longevity; and, indeed, there is no country in Europe where, in proportion to its population, a greater number of individuals reach to 60, and thence to 80, and even 90 years of age, in full poſſeſſion of all their faculties, both perſonal and mental, than is the caſe in that part of Great Britain *. There is alſo every

* In a work containing a collection of inſtances of longevity for no leſs a period than 733 years, namely, from A. D. 1066 to 1799, (by J. Eaſton) in which there is given the name, age, place of reſidence, &c. of 1712 perſons, from all parts of the world, who had attained to a century and upwards, 170 are ſtated to have been natives of Scotland, and the two moſt remarkable in the whole liſt are Kentigern, a native of Scotland, and Peter Torton, of Temeſwar, in Hungary, both of whom attained the great age of 185 years. This Kentigern, alſo known under the name of Saint Mungo,

every reaſon to believe that many of the departments of France, and the mountainous diſtricts of Germany, Hungary, Sweden, Norway, and even thoſe of Spain, Portugal, Italy, and America, will produce extraordinary inſtances of longevity whenever any particular inquiry is made regarding that intereſting circumſtance.

IV. *Tables of Longevity.*

Having thus diſcuſſed the ſubject of longevity in general, it may not be improper to lay before the reader the following table, explaining the ſhortneſs of human life, and pointing out how few there are, in proportion to the number born, who reach even the period of 60 years *.

Of a hundred men who are born, there die, according to Hufeland,

Under 10	50
Between 10 and 20	20
20 and 30	10
30 and 40	6
40 and 50	5
50 and 60	3
	94

Hence it would appear that there are only ſix out of a hundred who ſtand a chance of living beyond 60 years.

Of perſons who have lived above a hundred years, the induſtrious Haller has collected 1113 inſtances, and gives the following ſtatement of the duration of their lives †.

Of thoſe who lived from 100 to 110 years, the inſtances have been above 1000

From 110 to 120 about	62
120 to 130	29
130 to 140	15
140 to 150	5
152 (Parr)	1
169 (Jenkins)	1
	1113

Mungo, was the founder of the biſhopric of Glaſgow. The following verſes were made on his extraordinary age and place of interment:

"Cum octogenos centum quoque quinque vir annos
"Complerat, Sanctus eſt Glaſgow funere functus."

Spottiſwood's Hiſt. of the Church of Scotland, p. 11 and 112.

* On the Art of prolonging Human Life; a work written by profeſſor Hufeland, of Jena, in Germany.

† Haller's Elementa Phyſiologiæ Corporis Humani, vol. viii. lib. 30. ſect. 3. p. 103.

But in a recent publication, the following table is given as the result of a more extensive collection of instances of longevity.

Of males and females who lived from 100 to 110 years, both inclusive, the instances have been -	1310
Above 110 to 120 - - -	277
120 to 130 - - -	84
130 to 140 - - -	26
140 to 150 - - -	7
150 to 160 - - -	3
160 to 170 - - -	2
170 to 185 - - -	3
	1712*

Conclusion.

Such is the substance of the observations which have occurred to me on this interesting subject. I shall conclude with remarking, that on the whole it is more than probable, by proper attention and good management, persons in general might not only live longer, but might enjoy life with more relish, than is commonly the case at present; and it is to be hoped, in respect of this, as well as of many other particulars, that human nature is still in the threshold of acquirement, that it will yet obtain greater and more important acquisitions of knowledge, and may reach further improvement both with regard to the extent of personal and mental gratifications, which our species may be found capable of enjoying, and also the means of possessing them, with more satisfaction and comfort, and for a much longer period of time.

[To be continued.]

XXIX. *Memoir on the Anatomy of Vegetables. Read before the Physical Class of the Institute by* C. Mirbel.

[Continued from p. 40.]

Chap. IV.

Of the tubular Tissue.

There are two kinds of tubes, the great and the small.

Art. I. *Of the large tubes.*—The large tubes during the first period of their formation are not, as might be supposed, membranaceous canals separate and distinct from the tissue;

* See Easton on Longevity, printed an. 1799.

and

and they exiſt only becauſe there is a lacuna in the membranes. Such is the extreme ſimplicity of the organization of vegetables, that all the difference obſerved in them is merely confined to ſome modifications in the cellular tiſſue. But the ſides of theſe large tubes, being continually moiſtened by the fluids imbibed by the plant, gradually aſſume more conſiſtence, and ſeparate from the reſt of the tiſſue when their ſolidity ſurpaſſes that of the ſurrounding membranes. I could never obſerve large tubes in muſhrooms, lichens, and fuci, even when I employed a microſcope; but it is ſufficient to have good ſight to be able to diſtinguiſh the aperture of theſe canals on the tranſverſal ſection of the ſtems, the branches, and roots, of ſeveral monocotyledons and dicotyledons. In the former, they are always found in the centre of the ligneous filaments, and ſometimes they compoſe the major part; in the ſecond they are diſtributed often, as it were, at random in the wood; ſometimes alſo they form groups placed very regularly at certain diſtances, or they are ranged in concentric zones. They are exceedingly numerous, in particular around the medullary canal. They are found alſo in the bark. If their progreſs be followed they will be ſeen to have their origin in the root, to enter the trunk, and to riſe parallel to each other: then to unite, to ſeparate and deviate from their vertical direction, to penetrate the bud which is formed at the ſurface of the bark; to lengthen with it, and to diſtribute themſelves throughout all its ramifications, to paſs from the branch into the ligneous filaments the bundle of which compoſes the petiole, and to divide themſelves among the large fibres of the leaves as the arteries and veins diſtribute themſelves in the human body. They may be obſerved alſo in the fibres of the perianthes, the filaments of ſome ſtamina, the piſtils, and the ligneous filaments which traverſe the pulp of fruits. Scarcely is the embryo formed when theſe tubes are obſerved. In this infancy of the vegetable they are not concealed by the wood, which does not yet exiſt: the ſubſtance deſtined to produce it is then in a ſtate of fluidity, which permits the obſerver to examine the parts which it covers. It is not yet the proper place for ſpeaking of the vegetable chyle produced by the fluids aſſimilated in the veſſels of the plant, I ſhall recur to that ſubject hereafter. The large tubes form ſometimes medullary radii, as I have obſerved in the equiſetum or horſe-tail; but, in my opinion, this caſe is rare.

The large tubes are of four kinds: ſimple tubes, porous tubes, falſe tracheæ, and tracheæ. Theſe are modifications of the ſame organ.

1ſt, *Simple*

1ſt, *Simple tubes.*—The ſides of theſe tubes are perfectly whole, neither pores nor fiſſures are obſerved in them: they generally contain reſinous or oily juices, known under the denomination of *proper juices*. Theſe tubes are very remarkable in green trees, in euphorbia, periploca, and, in general, in all plants the juices of which are thick. They are more numerous and more viſible in the bark than in any other part.

2d, *Porous tubes.*—The ſides of theſe tubes are perforated with ſmall pores ſimilar to thoſe mentioned in the article on the cellular tiſſue, with this difference, that they are much more numerous, and that, inſtead of being diſſeminated by chance, and without order, as is often the caſe, in the cells, they are diſtributed in regular and parallel ſeries around the tubes. Theſe tubes do not appear to be ſo peculiarly deſtined as the preceding to contain reſinous or oily juices. They are very numerous in hard wood, ſuch as the oak.

3d, *The falſe tracheæ.*—Theſe tubes are interſected in a tranſverſal direction with parallel ſlits, which from their appearance might induce us to believe that they are formed of rings placed one above the other, or of filaments twiſted in a ſpiral form; but they cannot be unrolled, or ſeparated into diſtinct rings; and beſides, with a little attention, one may diſcover the continuity of the membrane, and conſequently the place where the ſlits end. Theſe, then, are porous tubes, but their pores are much larger than thoſe of the preceding. I muſt even obſerve, that the edge of the ſlits is furniſhed with a roll ſimilar to that which ſurrounds the ſmall pores. Theſe tubes are deſtined for the ſame purpoſes as the porous tubes; but in general they are found in thoſe kinds of wood which are leſs hard and compact, and even in herbaceous plants: I have obſerved them in a great number of the monocotyledons. The centre of the lycopodia preſents a thick cylinder compoſed, in a great meaſure, of veſſels of this nature. Ferns contain alſo a great many in their ligneous filaments. Dicotyledons are likewiſe provided with them. They are exceedingly numerous in the vine, the wood of which is ſoft and porous.

4th, *The tracheæ.*—Want of experience has aſſigned to theſe tubes, which have not been ſufficiently obſerved, a denomination conſecrated by cuſtom. The tracheæ of plants have a reſemblance in their form to the tracheæ of inſects, and it has thence been concluded, on too ſlight grounds, that theſe tracheæ in the former as well as in the latter muſt be the organs of reſpiration. The vegetable trachea is a tube formed of a filament twiſted into a ſpiral form from right to left.

left. This filament is opake, brilliant, argenteous, and thick. Its tranſverſal ſection preſented to me ſometimes a flat plate or an ellipſis, and ſometimes even two filaments united by an intermediate membrane; but I never could obſerve the aperture of a tube, as ſeveral authors have aſſerted. The ſurface is ſometimes ſmooth, ſometimes unequal, and ſometimes porous. The ſpirals of the tracheæ are often ſo cloſe, that when their arrangement is not diſturbed, on breaking or cutting, without precaution, the parts which conceal them, they appear to be continued tubes ſlightly ſtriated. Malphigi and Reichel ſay that choked parts have been remarked in the length of the tracheæ; and at firſt I believed that I obſerved the ſame, but I have ſince found that this was merely an optical illuſion. Theſe tubes exiſt in great numbers in the herbaceous monocotyledons and dicotyledons, but eſpecially in the aquatic kinds, the tiſſue of which is weaker: they occupy the centre of the ligneous filaments in the monocotyledons; in trees with two cotyledons they are ſeen around the pith: in theſe they are often mixed, and confounded with the falſe tracheæ. I never ſaw them in the hard parts of vegetables, unleſs theſe parts had long been in a ſtate of ſoftneſs, which permitted the tracheæ to expand: this is what takes place in branches and twigs from which the pith has diſappeared. Theſe tubes have formed themſelves when the medullary ſubſtance exiſted. The tracheæ are not found in the length of the bark; they penetrate into the petioles and leaves in the ſame manner as the falſe tracheæ; they every where act the ſame part as the latter, and do not contain thick juices but in plants where they are very abundant, ſome as of the lily kind. It is well known that, to ſee theſe organs with the naked eye, it is neceſſary to take a young, green, and ſoft branch, to twiſt and break it without violence, that the tracheæ may be unrolled without rupture: if the two parts of the branch which have been divided be then oppoſed to the light, one can diſtinguiſh the half-unrolled filaments which proceed from the one part to the other, and the ſpirals are cloſe or at a diſtance, according as the parts are brought near to, or removed from, each other. They unroll themſelves or contract in the ſame manner in leaves which have been torn. The leaves, however, of the *butomus umbellatus* exhibit a contrary phænomenon; the tracheæ, which in this plant are exceedingly numerous, when once unrolled no longer contract themſelves.

Let us now return to the large tubes in general. The diviſion into ſimple tubes, porous tubes, falſe tracheæ, and tracheæ,

tracheæ, is not rigorous. In eſtabliſhing it, I do not pretend to aſſign immutable laws of nature; I have had occaſion to obſerve that it often deviates from them. Thus the *butomus umbellatus* exhibits in the ſame tube the pores of the porous tubes, the ſlits of the falſe tracheæ, and the ſpirals of the true tracheæ; ſo that one tube comprehends three of the modifications I have deſcribed. Theſe tubes I call the mixt. Other vegetables exhibit ſomething analogous or in ſimilar ſituations, there are found in them one of the four varieties of the large tubes. It is not uncommon to ſee all theſe tubes cloſely united the one to the other, and forming only one tiſſue. In a word, it may be conjectured, with ſome appearance of reaſon, that in many caſes the tracheæ unroll themſelves only becauſe the membranes which unite their ſpirals are torn. Let us conclude then that theſe differences, which on the firſt view appear of ſo much importance, are only ſlight ſhades in the vegetable economy. But the large tubes, conſidered in a more general manner, preſent themſelves to the mind as the creative organs; their numerous ramifications diſtributed throughout all the parts of the vegetable carry thither the vivifying juices; by theſe the ſtem acquires more vigour, the bud is produced, pierces the bark, and lengthens under the form of a branch; the leaf expands, the flower blows, and the fruit ſwells up and ripens, while the embryo concealed in its boſom receives its firſt nutritive juices.

Article II.

Of the ſmall Tubes.

Theſe are compoſed of cells united to each other like thoſe which compoſe the cellular tiſſue; but in the cellular tiſſue the diameter of the cells is nearly equal in every direction; while in the former the cells are much elongated, and form real tubes, the extremities of which are ſhut: the ſides alſo are leſs tranſparent, and the membranes of which they are formed have more conſiſtence: they are often perforated with a great number of pores. This tiſſue is thick, ſolid, and tenacious. It is generally difficult to cut it through; but it preſents much leſs reſiſtance lengthwiſe, and often ſeparates eaſily into threads of greater or leſs delicacy, and which very improperly have been called fibres. The ſolidity of the vegetable depends in particular on the quantity and denſity of this tiſſue: it contains, according to the ſpecies in which it is found, ſometimes thick and coloured juices, but ſometimes, and more commonly, limpid and colourleſs juices. In the

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ſir it is impregnated with a reſinous liquor; in the vine, eſpecially at the time of the ſap, it abounds with an aqueous fluid.

The embryo, ſtill incloſed in its teguments, has few or no ſmall tubes: all its parts are ſoft or almoſt mucilaginous. This tiſſue is never found but in the expanded plant. It is obſerved in the centre or at the circumference of the ramifications of certain ramified lichens, and in the ſtems of moſs: in monocotyledons, this tiſſue diſtributed around the large tubes forms the ligneous filaments; in dicotyledons, placed around the pith, and the large ſurrounding tubes, it forms the ligneous ſtrata. The ſmall and large tubes are generally united: the exiſtence of the former depends on the preſence of the latter. The bond which connects them is nothing elſe than that which unites the effect to the cauſe. Large tubes, however, are ſometimes found without the ſmall, and the ſmall without the large; but it is to be recollected that the latter are the creative organ, and conſequently their exiſtence is independent of that of the others. So much for the firſt caſe. And it muſt be conſidered that there is an epoch for many vegetables at which the large tubes are filled up with the tiſſue to which they gave birth. So much for the ſecond caſe.

The prominent parts of the grooves and ſtriæ which cover the ſurface of the vegetables are bundles of ſmall tubes. This tiſſue is obſerved alſo in the moſt delicate ribs of the leaves and petals: it penetrates the ſtamina and piſtils, and reaches to the extremity of the ſtigmata; but in theſe delicate organs it loſes its rigidity, and is nothing but cellular tiſſue very much elongated.

Chap. V.

Of Lacunæ.

Nature, which effects expanſion without violence, and which conducts organized beings, by inſenſible gradations, from non-exiſtence to life, and from life to death, ſeems here to deviate from her uſual progreſs: ſhe deſtroys to create, and from the annihilation of organs gives birth to a new organic ſyſtem. Lacunæ are regular and ſymmetric vacuities formed in the interior of vegetables by the laceration of their membranes.

Lacunæ, in general, exiſt only in plants, the tiſſue of which is ſoft. They are very numerous in moſt of the aquatic herbs. They are, however, found ſometimes in vigorous trees the wood of which is very hard; but in all caſes they are formed only by the deſtruction of the cellular tiſſue, which is the weakeſt

weakeſt part of the membranous tiſſue. If lacunæ occur more frequently in the monocotyledons, it is becauſe theſe vegetables in general have leſs vigour, and an organization leſs perfect; or, if I may venture to ſay, leſs vegetative power. A phænomenon which deſerves the attention of phyſiologiſts is, that theſe lacerations inſtead of hurting the vegetable ſerve only to increaſe its ſtrength by concentrating it more. Plants the texture of which is flaccid, and thoſe in particular immerſed in water, receive juices in abundance; but they cannot aſſimilate them, becauſe the organs are not ſufficiently vigorous in proportion to the volume of theſe plants, which have more ſize than real ſtrength. But if by internal rupture the organs which have become uſeleſs are deſtroyed and the uſeful organs are retained; in a word, if one part of the organization is ſacrificed to the other, the part which maintains itſelf receiving the whole nutritive ſubſtance will acquire more ſtrength, and the vegetable may ſtill grow with new vigour; for its ſtrength will not be diminiſhed, and its impediments will be leſs.

No lacunæ are obſerved in the embryo, becauſe its lacerations are a real diſorganization, which cannot take place in beings that begin to live. They are formed therefore only in the courſe of time. They ſhow themſelves in the petioles of fern, in the ſtems of the potamogetons, and in a multitude of other vegetables like longitudinal tubes interſperſed throughout the cellular tiſſue. In the equiſeta they affect a diſpoſition exceedingly regular; one greater than the reſt forms a tube in the centre of the ſtem; around this tube there are other very ſmall lacunæ arranged circularly, and ſome larger and cloſer to the circumference are diſpoſed in alternate order with them. The lacunæ of the leaves of the monocotyledons are interſected by frequent partitions, which are only the cellular tiſſue collected at certain diſtances, and which cloſes the tubes by membranous diaphragms. This organization, or rather diſorganization, appears through the tranſparent tiſſue of the *typha*, and a multitude of other monocotyledons with ſword-formed leaves. The ſame phænomenon may be obſerved in the tiſſue of the ſheaths of which the ſtem of the banana-tree is compoſed.

The *reſtio* has longitudinal lacunæ, and alſo tranſverſal apertures in the thickneſs of the bark: it does not appear that the latter kind of lacuna occurs often in vegetables.

One might ſuſpect that the large tubes of plants always begin by being lacunæ, and that the internal vacuities, where a new tiſſue, which increaſes both the volume and denſity of the vegetable, is developed, are only lacunæ alſo.

CHAP.

Chap. VI.

Of the Glands.

Whether plants have glands analogous to thoſe of animals; that is to ſay, organs proper for giving to the fluids the qualities neceſſary for the development and preſervation of the being by making them undergo new combinations, and by ſeparating from them the uſeleſs or prejudicial qualities, is a queſtion not eaſy to be determined. In ſo delicate a ſubject, facts and reaſoning are equally obſcure: however, it appears to me beyond a doubt that we do not catch with our beſt microſcopes but the coarſe part of the vegetable organization. I cannot conceive that the transfuſion of the fluids of one cell into another is ſufficient to modify theſe fluids ſo far as to change them into organized matter, and to render them ſuſceptible of giving a new increaſe and new vigour to the plant. I cannot conceive either that the common laws of chemiſtry could alone effect this phænomenon, becauſe, in either hypotheſis, nothing could prevent labour or chance from unveiling to man the ſecret of nature: but this conſequence is repugnant to reaſon. It appears, then, to me more judicious to admit ſecretory organs in which the fluids are aſſimilated. It muſt, indeed, be ſuppoſed that the membranes are not impenetrable to the fluids, ſince they dilate, unfold themſelves, and change their nature; but they muſt neceſſarily modify the fluids, ſince the latter, by penetrating them, become capable of increaſing the membranous tiſſue in all its dimenſions: it is in the membranes, then, that we muſt ſearch for the vegetable glands. It might be ſuppoſed, with ſome appearance of truth, that the opake and irregular rolls with which the pores and apertures of the large tubes are bordered are glandulous bodies. The filaments of the tracheæ, the thickneſs of which greatly ſurpaſſes that of the membranes, ſeem alſo to diſcharge the ſame functions; and what gives to theſe probabilities more weight is, the conſideration that the mucilage, which is transformed into organized tiſſue, is always accumulated around the ſmall and large tubes, which are all covered with theſe opake bodies.

[To be continued.]

XXX. *Short Account of the Ornithorynchus Paradoxus, or Duck-billed Platypus.*

THIS animal, of all the quadrupeds yet diſcovered, ſeems to be the moſt extraordinary in its conformation, as it exhi-

bits the perfect resemblance of the bill of a duck engrafted on the head of a quadruped. So strong, indeed, is the similitude, that, when the stuffed animal was first brought to Europe, some naturalists were inclined to suspect that the bill was a deceptive preparation produced by artificial means; and it was not without the most rigid observation that they could persuade themselves that the beak or snout of the quadruped was real.

The length of the whole animal from the tip of the beak to that of the tail is 18 inches; that of the beak is $1\frac{3}{4}$ inch. The body is depressed, and has some resemblance to that of an otter. It is covered with very thick soft fur, of a moderately dark brown colour above, and of a somewhat ferruginous white beneath: the head is flattish, and rather small than large: the mouth or snout, as already mentioned, has so striking a resemblance to that of some broad-billed species of duck, that it might be mistaken for such: round the base of it there is a flat circular membrane rather wider below than above, that below being nearly the fifth of an inch, and that above an eighth. The tail is flat, and covered with fur like the body; it is rather short and obtuse, and has an almost bifid termination: it is broader at the base, and gradually decreases to the tip: it is about $4\frac{1}{2}$ inches in length, and its colour is similar to that of the body. The legs, which are short, terminate in a broad web, which in the fore-feet extends to a considerable distance beyond the claws, but in the hind-feet it reaches no further than the roots of the claws. The fore-feet have five straight, strong, and sharp-pointed claws; the two exterior ones somewhat shorter than the middle ones. The hind-feet have six claws, which are longer and more inclining to a curved form than those of the fore-feet: the exterior toe and claw are considerably shorter than the four middle ones: the interior or sixth is placed much higher up than the rest, and resembles a strong sharp spur. The legs are all hairy above; the fore-feet are naked both above and below. The internal edges of the under mandible, which is narrower than the upper, are serrated with numerous striæ, as in a duck's bill. The nostrils are small and round: they are situated about a quarter of an inch from the tip of the bill, and are about the eighth of an inch distant from each other. The ears are placed about $1\frac{1}{4}$ inch beyond the eyes; they appear like a pair of oval holes the eighth of an inch in diameter, without any external ear. On the upper part of the head a little beyond the beak there is on each side a smallish oval spot in which the eyes are placed, or at least those parts which seem allotted to the animal for some kind

of

of viſion: from the thickneſs of the fur and the ſmallneſs of theſe organs, they ſeem to be but ill calculated for diſtinct viſion, and, in all probability, are like thoſe of moles and ſome animals of that tribe. The whole apparent diameter of the cavity of each does not exceed the eighth of an inch.

The general form and ſtructure of this animal, and, in particular, its bill and webbed feet, evidently ſhow that it muſt be reſident in watery ſituations; that it has the habits of digging or burrowing in the banks of rivers or under ground; and that its food conſiſts of aquatic plants and animals. It is a native of New Holland. The average ſize is not yet aſcertained.

The annexed figure of this animal, given in Plate III., was delineated and engraved from a very complete preſerved ſpecimen in the poſſeſſion of W. H. Pepys jun. eſq.

For an anatomical deſcription of the head of this animal, and a figure, ſee Philoſophical Magazine, vol. xi. p. 366.

XXXI. *Curious Particulars reſpecting Bees.* *By Mrs.* Cooper, *of Wormley in Hertfordſhire.*

To Mr. Tilloch.

HAVING read many curious accounts of the management of bees by different authors, with plans propoſed for taking their honey without deſtroying them, I was reſolved to become an apiator, and on the 25th of Auguſt 1800 I purchaſed a hive of bees, which was ſuppoſed, by computation of judges, to weigh above twenty pounds. I fed them in the winter following with brown ſugar wetted with ale, which I put into a vehicle I call a boat, from its ſimilitude to a Caffree canoe, and which I make out of the young ſhoots of elder dried for the purpoſe, and juſt big enough to puſh into the door of the hive: ſometimes I give two a day, but never more, the whole not being above a good table ſpoonful. When the flowers began to ſhow themſelves in the ſpring of 1801, and I perceived them coming home loaded, I only fed them on ſuch days as they could not go out, and deſiſted from it entirely in the month of April.

The bees appeared healthy and very numerous, frequently covering the whole hive outſide, which I thought indicated their going to ſwarm: but in this I was totally diſappointed; and as the ſeaſon declined I began, the better to preſerve my bees, to feed them as the preceding year; which I continued until the flowers and honey dews convinced me they had enough. On the 4th of June 1802 my ſtock ſent forth a

very fine ſwarm, which I hived; and kept a good look-out for a caſt, but was in this diſappointed. On going to look at the hive about five o'clock one afternoon I found in front of it, on the graſs, a *queen bee*, anſwering the deſcription of all authors; but with this difference, though alive there was not any bee near her. I brought her into the houſe to examine her thoroughly, and to ſee if ſhe had met with any accident, but could not perceive any defect. I then put her on a twig, and, placing her at the door of the hive, the bees within ſoon led her into it. The time being elapſed when I had reaſon to expect a caſt, and anxious to increaſe my ſtock, I purchaſed from a neighbour, on Thurſday the 8th of July, a caſt, for which I paid five ſhillings and ſixpence; and on his bringing it home, I deſired him to remove my old hive to a new place, the better to ſee if any dirt or moth was under it, in order to clean it, and then to place the new caſt on the ſpot the old had occupied. This he performed.

The next day all was quiet; but the day after I perceived an uncommonly buſy communication betwixt the two hives; and on the Sunday I found the old hive totally deſerted, and that the bees had all joined the new caſt without any fighting whatever, leaving me a hive completely full, out of which I immediately took twenty pounds of fine liquid honey, and of which, Mr. Editor, you may partake any time you travel this way while it laſts. Thus I have ſaved my bees; which, I doubt not, were allured for want of room, their hive being quite full, and the new one being put in its place.

As chance has produced many great events, it may be worth the while of any apiator to try, by the purchaſe of a caſt at the time of the year I have done, whether it will not equally ſucceed *. I mention the time, becauſe I have doubts whether a later ſeaſon will permit the bees to ſtock themſelves with food ſufficient for the following winter; and it muſt be obſerved that this year, 1802, has proved a moſt uncommonly fine year for bees, from the numerous honey dews we have had. I remain, Sir,

Your obliged reader,
CHARLOTTE COOPER.

Wormley, Herts,
July 20, 1802.

* Does not the iſſue of the experiment related in this paper ſuggeſt alſo another? New empty hives have ſometimes been placed beſide full old hives, in the hope that the new ſwarm might take up its abode there; but we believe it has ſeldom anſwered the wiſh of the bee-maſter. If, however, as in the caſe before us, the old hive was put in a new place, and then an empty hive put on its old ſite, is there no probability that the bees would take poſſeſſion of the new hive; perhaps merely from want of room, but poſſibly from an idea that the contents of the old hive would ſtill remain in ſtore for them?—EDIT.

XXXII. *Ex-*

XXXII. *Extract from the Report made to the French Board of Longitude by* C. LAGRANGE, LAPLACE, MECHAIN, *and* DELAMBRE, *on the Lunar Tables ſent to the Board to compete for the Prize propoſed on that Subject.*

THE public will recollect with what intereſt the National Inſtitute received, two years ago, the memoirs of the aſtronomers Bürg and Bouvart reſpecting ſome of the elements of the lunar tables. Struck with the importance and immenſity of their labour, the claſs of the mathematical and phyſical ſciences, the preſident of which at that time was of all its members the one who could beſt enſure the eclat and ſucceſs of its deliberations, decreed that the prize to be offered ſhould be doubled. By doing much more than was required of them, the competitors gave birth to a queſtion far more difficult than that which they had ſolved. The ſame mean motion was not capable of ſatisfying the epochs which they had eſtabliſhed for the commencement, the end, and the middle of the 18th century.

This irregularity, ſo alarming for the future preciſion of the tables, could not be explained but by ſuppoſing, either that the inequalities already comprehended in the tables were not ſufficiently well known, or that there were ſtill wanting ſome equations which had hitherto eſcaped the reſearches of all geometricians.

The terrible labour which theſe new conſiderations required did not permit us to hope for ſo ſpeedy a ſolution as was neceſſary to the wants of aſtronomy and navigation. It was requiſite that an appeal ſhould be made to all aſtronomers, in the hope that ſome of them might have collected a ſeries of the neceſſary materials. The board of longitude applied with confidence to a government compoſed in ſuch a manner as to be ſenſible, much better than any other that ever exiſted, of the value of the ſciences and of the utility of their application. With its conſent, the miniſters of the interior and marine contributed in equal portions towards an extraordinary prize of 6000 francs (240l. ſterling), which they haſtened to propoſe to the emulation of the aſtronomers of all countries. Twenty months after this prize was announced, the board of longitude received the new tables of which we are going to give an account.

To verify the tables conſtructed from the whole maſs of the good obſervations publiſhed till that period, it was neceſſary to have other obſervations, equally good, but more recent. Choice was made of 150, both from the regiſters of

the national obſervatory of Paris, from the laſt publications of the aſtronomer royal in England, and from the correſpondence of the director of the obſervatory of Gotha. It is ſufficient to ſay, that it was impoſſible to find any deſerving of more confidence, either on account of the excellence of the inſtruments with which they were made, or the known merit of the obſervers.

We ſhall deſcribe in a few words the difficulties which the author of the tables had to ſurmount, and the preciſion to which he has attained.

By thouſands of compariſons he has proved, in the firſt place, that the periodical inequalities before determined were ſuſceptible only of very ſmall amelioration. He introduced ſome equations imperfectly indicated, and afterwards neglected, by Mayer and Maſon; and ſome others much more important, indicated in the laſt volumes of the *Connoiſſance des Tems* by C. Laplace: they rendered the tables much better, but did not correct the inequality of the mean motion.

It remained to try equations of a long period. As theory had not furniſhed any, the author endeavoured to determine empirically the law of the anomalies obſerved: he loſt himſelf in an inextricable labyrinth; but, at the time when, fatigued with ſo many vain efforts, he had renounced all hope, he learned that Laplace had diſcovered the form and arguments of two new equations, the determination of which he deferred till he could obtain a more preciſe obſervation. With this aid, almoſt unhoped for, our author undertook a new labour, and was able to fix the value of the two equations, which explained the whole in the happieſt manner. The reſult was, a more exact knowledge of the mean motion; a more perfect agreement between calculation and obſervation; and a well-founded hope that this agreement will be maintained, and that we ſhall no more ſee, as of late years, errors increaſe in a rapid and alarming manner.

This is not the place for entering into numerical details; they will be found in a paper and tables ſubmitted to the board. To give an idea of the preciſion of the new tables, it will be ſufficient to ſay that the errors which can be aſcribed to them very ſeldom amount to 12″: whence it follows, that the aſtronomer who obſerves the moon will rarely find between the real and the calculated place a greater difference than the thickneſs of the very delicate thread which is in the focus of the teleſcope; and, to ſhow of what importance this exactneſs is to navigation, we ſhall ſay, that as theſe 12″ of motion do not require above a minute of time, the navigator will never err eight minutes in his longitude, at leaſt

for the want of tables; ſo that, if he is able to introduce the ſame exactneſs into his obſervations, he may conſider the problem of the longitude as ſufficiently ſolved for practice.

The commiſſioners conclude that the new tables, by the immenſity of the labour which they ſuppoſe, the intelligence which directed the labour, the great ſuperiority they have over other tables, and the utility they will daily be of to aſtronomers and navigators, are altogether worthy of the prize.

(Signed) LAGRANGE, LAPLACE, MECHAIN; and DELAMBRE reporter.

This report having been adopted by the board, the ſecretary produced a proof that the new tables are the work of M. Bürg, adjunct aſtronomer of the imperial obſervatory of Vienna, already ſo advantageouſly known by the prize which he participated, in the year 8, with C. Bouvart. The preſident, therefore, in name of the board of longitude, adjudged the prize to M. Bürg, and it was agreed that a deputation ſhould be named to preſent the above report to the conſuls of the French republic. This deputation, conſiſting of C. Lalande, Bougainville, Fleurieu, and Chabert, were admitted on Friday, Meſſidor 6, to an audience of the firſt conſul; who, after having heard the above report, and aſked ſeveral queſtions, in regard to the labour and the author of it, was pleaſed to expreſs his approbation by doubling the promiſed ſum.

Dr. Maſkelyne, the aſtronomer royal of England, being informed of the correctneſs of the new tables, has requeſted a copy of them, that he may employ them in his calculations for the Nautical Almanac. The board of longitude congratulates itſelf on thus having an opportunity of giving to this diſtinguiſhed man of letters, one of the foreign aſſociates of the National Inſtitute, a mark of its high conſideration, and of the gratitude which it owes to him for the collection of excellent obſervations with which he has enriched aſtronomy during the courſe of 36 years.

XXXIII. *Proceedings of Learned Societies.*

FRENCH NATIONAL INSTITUTE.

IN the public ſitting of Meſſidor 17, year 10, the following papers were read:—1ſt, The new prize queſtions propoſed. 2d, Notice reſpecting the new planet of Dr. Olbers, by C. Lalande. 3d, Report made in name of a commiſſion appointed to conſider means proper for accompliſhing the

intention of the firſt conſul, who propoſes to eſtabliſh a prize for an important diſcovery in electricity or galvaniſm; by C. Biot. 4th, Hiſtorical notice reſpecting the life and works of C. Legrand d'Auſſi, by C. Leveſque. 5th, Report on the prize propoſed in regard to a queſtion in architecture, by C. Ameilhon. 6th, Report on the prize propoſed for the eulogy of Boileau-Deſpreaux, by C. Andrieux. 7th, Hiſtorical notice on the life and works of C. Dolomieu, by C. Andrieux. 8th, Short memoir on the origin of printing, by C. Daunou. 9th, Fragment of a free and abridged tranſlation of the third book of the Pharſalia, containing a deſcription of the ſiege of Marſeilles; by C. Legouvé.

The following are the new prize queſtions which have been propoſed:

Claſs of the Moral and Political Sciences.

Morals.—How far does the barbarous treatment to which animals are ſubjected intereſt public morality, and would it be proper to make laws on that ſubject?

The prize will be a gold medal of the weight of five hectogrammes (about 70l. ſterling), and will be adjudged in the public ſitting of Vendemiaire, year 12. No papers will be received after the 15th of Meſſidor, year 11.

Political Economy.—What influence has the progreſſive abolition of ſlavery in Europe had on the increaſe of knowledge and the riches of nations?

The prize will be a medal of the ſame value, and will be adjudged in the public ſitting of Nivoſe, year 12. Papers will be received till the 15th Vendemiaire, year 11.

Claſs of Literature and the Fine Arts.

Eloquence.—In the public ſitting of Germinal 15, year 9, the claſs propoſed as the prize queſtion for eloquence the eloge of Nicholas Boileau-Deſpreaux; but, as none of the papers preſented were thought worthy of the prize, the claſs propoſes the ſame ſubject again for the year 12.

The prize will be a gold medal of the value of five hectogrammes, and will be adjudged in the public ſitting of Vendemiaire, year 12. The papers muſt be tranſmitted to the ſecretary of the Inſtitute before the 15th of Meſſidor, year 11.

Claſs of the Mathematical and Phyſical Sciences.

Mathematics.—To make a new ſeries of experiments on the preſſure which water in a ſtate of motion exerciſes againſt a body at reſt, and that which the ſame fluid when at reſt exerciſes againſt a body in motion; making it a principal object of reſearch to meaſure the particular preſſure experienced by points

points properly distributed on the anterior, lateral, and posterior parts of the surface of the body subjected to experiment and placed at different depths in the fluid; to determine its velocity in different points of the streams which are nearest the body; and, in the last place, to determine the curves which these streams affect, the point where they begin to deviate from the general direction of the progressive motion of the body, and that where they unite behind it.

The prize will be a medal of the weight of five hectogrammes, about 70l. sterling, and will be adjudged in the public sitting of the month of Nivose, year 13. No papers will be received after the 30th of Fructidor, year 12.

Physics.—The class proposed on the 15th of Germinal, year 8, as the subject of a prize the following question:—"To determine, by accurate experiments, the influence which atmospheric air, light, water, and earth, have upon vegetation." As two memoirs only were transmitted on this subject, neither of which was thought worthy of the prize, and as the class apprehend that the extent of the question may have discouraged those capable of examining it with the best success, they now confine it to one of its elements, and propose as follows:—"To determine, by experiment, the different sources of the carbon in vegetables."

The prize will be doubled, and consist of the value of two kilogrammes of gold, about 280l. sterling. The determination of the class will be published in the public sitting of the month of Nivose, year 13. The papers must be transmitted to the secretary of the Institute before the 1st of Vendemiaire the same year.

The class has thought proper also to remind chemists of the subject proposed for the first time on the 15th of Germinal, year 8, the renewed period of which will expire on the 1st of Nivose, year 12. It is as follows:—"What are the characters which in vegetable and animal matters distinguish those which serve as ferment from those in which they produce fermentation?"

Report made to the Class of the Mathematical and Physical Sciences of the Institute on the Prizes founded by the First Consul for Discoveries in regard to Electricity and Galvanism.

The first consul, who even amidst the cares of war has caused the sciences to flourish, being desirous that the peace should carry them to the highest degree to which they can attain, has given to the National Institute the means of accelerating their progress.

His

His intentions in this respect are expressed in the following letter, which was transmitted to the class by the minister of the interior: Paris. Prairial 26. n. 10.

"I intend, citizen minister, to found a prize consisting of a medal of 3000 francs (about 120l. sterling) for the best experiment which shall be made in the course of each year on the galvanic fluid. For this purpose, the memoirs containing the details of the said experiments shall be sent before the 1st of Fructidor to the first class of the National Institute, which in the complementary days shall adjudge the prize to the author of that experiment which has been most useful to the progress of science.

"I desire to give, by way of encouragement, the sum of 60,000 francs (2400l.) to the person who by his experiments and discoveries shall, according to the opinion of the class, advance the knowledge of electricity and galvanism as much as Franklin and Volta did.

"Foreigners of all nations are admitted to the competition.

"I beg you will make known these dispositions to the president of the first class of the National Institute, that it may give to these ideas such development as may appear proper; my particular object being to encourage philosophers, and direct their attention to this part of philosophy, which, in my opinion, may lead to great discoveries.

(Signed) "BONAPARTE."

The National Institute, which has taken an active part in the grand discoveries with which the theory of electricity has been enriched, will be fully sensible of the importance of the subject indicated by the first consul. Of all the physical forces to which natural bodies are subjected, electricity appears to be that the influence of which is oftenest manifested. It not only acts on inorganic substances, which it modifies or decomposes, but organized bodies themselves experience from it the most astonishing effects. What to the antients was only the simple result of some attractive properties, has become for modern philosophers the source of the most brilliant discoveries.

The history of electricity may be divided into two periods, which are distinguished as much by the nature of the results as by that of the apparatus employed to obtain them. In one, the electric influence is produced by the friction of glass or of resinous matters; in the other, electricity is put in motion merely by the mutual contact of bodies. We must refer to the first of these epochs the distinction between the two kinds of electricity, resinous and vitreous, the analysis of the Leyden flask, the explanation of thunder, the invention of

of conductors, and the exact determination of the laws according to which the repulſive force of the electric matter varies according to the diſtance. The ſecond comprehends the diſcovery of the muſcular contractions excited by the contact of metals, the explanation of theſe phænomena by the motion of metallic electricity; and, in the laſt place, the formation of the electric pile, its analyſis, and its various properties. Volta has done in this ſecond period what Franklin did in the firſt.

The ſciences are now ſo connected with each other, that every thing which tends to improve the one advances the reſt at the ſame time. Under this point of view, galvaniſm, in the hiſtory of them, will form a memorable epoch; for there are few diſcoveries which have given to philoſophy and chemiſtry ſo many new facts, and facts ſo remote from thoſe before known. The aggregate of theſe facts has been referred to a general cauſe, which is the motion of electricity: it remains to determine accurately the circumſtances by which they are accompanied, to follow the numerous applications they ſuggeſt, and to diſcover the general laws which, perhaps, are contained in them. The greater part of the chemical effects preſented by the new kinds of apparatus are not yet completely explained; and it is of the more importance that they ſhould be well known, as they furniſh to chemiſtry means very powerful for decompoſing the moſt intimate combinations. It is alſo intereſting to examine whether the electric properties which certain minerals acquire in their variations of temperature do not depend on a diſpoſition of their elements analogous to that which conſtitutes the Voltaic pile. In a word, it is to be deſired that the theory of electricity augmented by theſe new phænomena ſhould be completely ſubjected to calculation in a general, direct, and rigorous manner; and the progreſs already made in this path has proved that this difficult ſubject requires the ſagacity of the moſt ingenious philoſophy and the aid of the moſt profound analyſis.

But it is in its application in particular to the animal economy that it is of importance to conſider the galvanic apparatus. It is already known that metals are not the only ſubſtances the contact of which determines the movement of electricity. This property is common to them and ſome liquids, and it is probable that it extends, with divers modifications, to all the bodies of nature. Do not the phænomena exhibited by the torpedo and other electric fiſhes depend on an analogous action exerciſed between the various parts of their organization? and does not this action exiſt with a degree

degree of intensity less sensible, but no less real, in a number of animals much greater than has hitherto been believed? An exact analysis of these effects, a complete explanation of the mechanism which determines them, and a comparison of them with those exhibited by the Voltaic pile, would, perhaps, afford a key to the most important secrets in the animal economy. By thus considering the aggregate of these phænomena, one foresees the possibility of a grand discovery, which, by unveiling a new law of nature, may conduct them to the same cause, and connect them with those which the motion of electricity has presented us in minerals.

Of these considerations the class was, no doubt, sensible; and if it did not propose a prize for the improvement of this part of philosophy, it was for this reason, that, as the extent of the subject seemed to require more than one competition, it could not devote to it exclusively encouragements which it owes to useful knowledge in general. However, each of its members, and all the learned of Europe, ardently desired that the researches of philosophers might be directed towards this important object, and they ought to congratulate themselves on seeing their wish accomplished in the most complete manner.

To fulfil the intentions of the first consul, and give to the competition all the solemnity which the importance of the object, the nature of the prize, and the character of the founder require, the commission unanimously propose as follows:

The Class of the Mathematical and Physical Sciences of the National Institute opens the general competition required by the first consul.

All the learned of Europe, even the members and associates of the Institute, are admitted to the competition.

The class does not require that the memoirs should be immediately addressed to it. Every year it will crown the author of the best experiments which shall come to its knowledge, and which shall have advanced the progress of the science.

The grand prize will be given to the person whose discoveries shall form a memorable epoch in the history of electricity and galvanism.

The present report, containing the letter of the first consul, shall be printed, and serve as a programme.

Done at the National Institute, Messidor 11, year 10.

(Signed) Laplace, Halle, Coulomb, Hauy; and Biot, reporter.

The

The report and its concluſions are adopted. It ſhall be read at the next public ſitting.

Certified agreeably to the original.

(Signed) LACROIX, ſecretary.

BATAVIAN SOCIETY OF THE SCIENCES AT HAARLEM.

This ſociety has propoſed the following queſtions till the 1ſt of November 1803:

1ſt, What have we been taught by the lateſt obſervations in regard to the influence of the oxygen of atmoſpheric air in changing colours, whether aided with the action of light or not; and what advantages can be thence derived?

2d, What have we learned from the diſcoveries reſpecting the decompoſition of water and atmoſpheric air in regard to the manner in which plants obtain their nouriſhment; and what concluſions can thence be deduced for improving the culture of uſeful vegetables?

3d, What has experience taught us in regard to the purifying corrupted water and other impure ſubſtances by means of charcoal? How far can the manner in which this is done be explained from the principles of chemiſtry; and what further advantages can be derived from it?

The ſociety have extended alſo to the 1ſt of November 1802 the three prizes, propoſed in 1799, reſpecting the chemical diſcoveries in regard to the phyſiology of the human body; alſo the queſtion propoſed in 1796, and repeated in 1799, reſpecting the whale fiſhery; the queſtion, propoſed in 1800, reſpecting Chladni's vibration figures; and the two queſtions, propoſed in 1801, on the nature of fire, and the application of it to produce heat, and on preventing the corruption of ſtagnant water.

They have repeated alſo, for an indefinite time, the three following queſtions, propoſed 1793—1795, on the utility of animals apparently pernicious; on the uſe, in the *materia medica*, of unknown indigenous plants; and on the plants, not yet in uſe, which may be employed as found and wholeſome nouriſhment.

MEDICAL SOCIETY AT MONTPELLIER.

This ſociety has propoſed the two following queſtions, the prizes of which will be adjudged, the firſt in May 1803, and the ſecond in May 1804. The prize for each is 500 francs.

1ſt, To determine in what kind of chronic diſeaſes, and under what circumſtances, inflammation may be uſeful or dangerous; and in what caſes in the treatment of theſe diſeaſes it ought to be excited or moderated?

2d, To eſtabliſh, from experience and obſervation, what degree of confidence ought to be given to the method of uſing by friction certain ſubſtances which are generally adminiſtered internally? To determine the effects of theſe medicines when taken internally and applied by friction, and how ſtrong the doſes ought to be? To point out the circumſtances and diſeaſes in which either of theſe methods deſerves the preference? And, in the laſt place, to determine what parts of the body can be employed in different diſeaſes for the more effectual application of theſe remedies?

XXXIV. *Intelligence and Miſcellaneous Articles.*

AEROSTATION.

THE attention of the public has been lately directed to this art, almoſt forgotten in England, by the arrival of M. Garnerin from Paris with two aëroſtatic machines of conſiderable ſize, and a parachute, which have been exhibited for ſome time paſt in the Pantheon. As this art, however little it may promiſe in other reſpects, has been found beneficial in military tactics, and might be employed with great advantage in making meteorological and ſtatical experiments, it is well worth the notice of ſcientific men: we therefore hope that the following particulars reſpecting M. Garnerin's two aërial excurſions in England, on the 28th of June and 4th of July, will be gratifying to our readers, and particularly to thoſe who had not an opportunity of ſeeing him aſcend. In a future number we intend to give a conciſe hiſtorical view of the progreſs of aëroſtation, with an engraving of M. Garnerin's balloons and his parachute.

The firſt Voyage.

In this excurſion M. Garnerin was accompanied by captain Sowden, who paid him a ſum of money to enjoy the gratification. They aſcended from Ranelagh gardens; and the particulars, as detailed by M. Garnerin, were as follow:

The morning of the 28th (the day of his aſcent) appeared to promiſe weather ſufficiently favourable for the purpoſe, though it was rainy. At eleven o'clock, therefore, he began the chemical operations neceſſary for the production of the inflammable gas. The balloon filled rapidly, though conſiderably agitated by the wind.

From one o'clock to half paſt four, the wind continued to increaſe, and at length blew ſo violently, that, had he made any

any previous experiment in this country, he ſhould have yielded to the earneſt ſolicitations of the brilliant and numerous company with which he was honoured, and ſhould have deferred his aſcent to a period leſs tempeſtuous.

M. Garnerin, however, though he determined not to diſappoint the public expectation himſelf, felt it to be his duty to preſs captain Sowden not, for the ſake of curioſity, to expoſe himſelf to the perils attendant upon ſuch a journey in ſuch weather. The captain, however, reſiſted all theſe ſolicitations, and reſolved to accompany him. From a quarter paſt four to five ſome ſhowers of rain fell, which only allayed the fury of the wind for a ſhort time, for after they had ceaſed it blew with more violence than ever.

At five o'clock Meſſrs. Garnerin and Sowden took their ſeats, the cords were cut, and the balloon aſcended. Each held a flag of the nation to which he belonged, which he waved to the company preſent. The balloon firſt made the tour of the place where the ſpectators ſtood, and, after being greeted with the loud plaudits and good wiſhes of every perſon, aſcended majeſtically and rapidly into the regions of the air. The wind blew from the ſouth-weſt. The balloon, therefore, proceeded over St. James's park, the Thames, and Weſtminſter and Blackfriars bridges.

M. Garnerin then found that the balloon began to deſcend: he threw out ſome ballaſt, and it roſe immediately with great rapidity, and carried the travellers over the cathedral of St. Paul's.

During all this time, the whole metropolis was diſtinctly ſeen by the aëronauts, whoſe balloon was equally viſible to the inhabitants of the metropolis. When it was over St. Paul's, M. Garnerin aſked captain Sowden how he felt himſelf? The captain replied, that he was perfectly enchanted with his ſituation, and with the ſuperb expanſe of ſky, and with the earth, now faſt leſſening to the view, and ſoon to be ſeen no more. The temperature of the atmoſphere now began to change very ſenſibly, and to be fifteen degrees colder than when they began to aſcend. It was extremely cold. The balloon continued rapidly to aſcend, was ſoon above the clouds, and the earth was viſible no more. When the travellers were above the clouds, the climate became ſenſibly milder: the inflammable air began to dilate, and M. Garnerin gave it all poſſible means of vent proper for their ſafety.

They now dined with good appetites, and very comfortably, above the clouds, at an elevation of upwards of 10,000 feet above the earth. During the deſſert, M. Garnerin told captain Sowden that the pleaſanteſt part of their journey was paſſed,

paſſed, and that they muſt now prepare for a very diſagreeable deſcent, on account of the continued violence of the wind.

About half an hour had elapſed ſince their aſcent. M. Garnerin now opened the valve, and the balloon deſcended through black and cold clouds; they then deſcried land again, and alſo the ſea, towards which their courſe was faſt carrying them: indeed they were nearly over that arm of it into which the Chelmer empties itſelf.

As ſoon as they had approached ſufficiently near the earth, they threw out their anchor and cable. When the balloon firſt touched the ground, it rebounded with conſiderable violence; this rebound was followed by about twenty more, more violent than the firſt. The guſts of wind dragged them over fields and hedges, which tore their hands and clothes; their anchor touched the ground ſeveral times, but dragged; and it was not till ſome minutes had elapſed that it took a ſteady hold in a thicket near a houſe. Here they conceived themſelves to be releaſed from all peril: but the inhabitants of the houſe, alarmed at the balloon, would not aſſiſt them; nay, actually offered to fire on the adventurous travellers. In the mean time the cable of the anchor broke, and they were dragged through trees and branches, the balloon being agitated to an extreme degree, and rebounding very violently. At length they were driven againſt a tree, and captain Sowden received a ſevere blow on the back part of his head. The balloon was now torn in the lower part, the cords broke, the boat broke; the travellers had hold of a tree, from which they were torn by the violence of the wind. At laſt, a bound which the balloon made, enabled them to jump out. The balloon, abandoned to itſelf, and much torn, fell about 200 paces further.

The place where M. Garnerin and captain Sowden landed was on a common, four miles beyond Colcheſter, and ſixty miles from Ranelagh. The time that elapſed from their departure to their landing on the common was three quarters of an hour.

M. Garnerin's hands were much torn, and his legs and thighs conſiderably bruiſed. Captain Sowden received a ſevere blow on the back part of his head, and was much bruiſed and torn in other parts of his body by the buſhes and trees againſt which they were driven.

M. Garnerin pays the higheſt tribute to the courage and coolneſs of his companion, who, after the balloon had firſt rebounded, could ſeveral times have jumped out of it with great eaſe and ſafety: but he perſiſted in ſharing the fate of his companion, till they were both enabled to land in ſafety.

Captain

Captain Sowden's Account.

Mr. Editor,

As numberleſs queſtions have been put to me reſpecting the ſenſations I experienced while in the upper regions, I think it a duty incumbent on me to inform the public, and to ſet them right as to the erroneous ideas they have of an aëroſtatic voyage. On our firſt aſcending, we felt a few drops of rain. After we had gained the height of about 3000 feet, I deſired M. Garnerin not to aſcend any higher till he had paſſed the metropolis, that the inhabitants might be gratified with a fair view of us. When we had got at a ſmall diſtance from London, we aſcended through ſome very thick clouds, of which I could perceive three diſtinct rows, at the lower one of which we found the quickſilver of the thermometer at 15°, and I was obliged to put on my great coat; but on aſcending ſtill higher we found the air more temperate, and the quickſilver riſe gradually to 5 above ſummer heat. We then ſeemed to be ſtationary, and felt no more motion than one would feel in ſitting in a chair in a room. I then propoſed to M. Garnerin to overhaul our lockers, where we found a ham, a cold fowl, a cake, and two bottles of orgeat, wines or ſpirits being dangerous to take, owing to the rarefaction of the air. The chill of the clouds having given us an appetite, we made a table on our knees with the ſeats of the car, and ate a very hearty meal. The clouds then diſperſed from under us, and we had a delightful view of the country.

Whether it is owing to the rarefaction of the air, or to the ſtrong light thrown on the earth, I cannot determine, but I found that my ſight, which at all times is rather weak, became ſo ſtrong, that I could eaſily diſtinguiſh the minuteſt objects on the earth: it appeared like a vaſt panorama, or map, of about fifty miles in circumference, where we could not only follow with our eyes the different croſs roads and interſections on it, but even diſtinguiſh the ruts on them, and the very furrows in the field. The ſenſe of hearing was ſtronger here than on earth; for, at the height of 15,000 feet, we could diſtinctly hear the rattling of the carriages on the roads, the lowing of cattle, and the acclamations of the people who ſaw us; though, at the ſame time, we could hardly hear ourſelves ſpeak: and I am perſuaded that a perſon on the earth, with a ſtrong voice and a ſpeaking trumpet, might make himſelf perfectly underſtood by any perſon at that height in the air. I have obſerved that almoſt every ſenſation I experienced while in the upper regions was exactly the contrary to what is the general opinion of the public. I was aſſured by a number of the moſt celebrated literati, who pre-

tended to be very learned on that ſubject, that I ſhould find the cold increaſe, the higher I aſcended; inſtead of which I found the heat increaſe to that degree, that I was obliged to take both my great coat and jacket off. It is alſo the general opinion that looking down from ſo ſtupendous a height renders a perſon ſo giddy as not to be able to keep his ſeat: on the contrary, I found that I could look down with a vaſt deal of pleaſure, and without experiencing that inconvenience; whereas looking round on the vaſt expanſe that ſurrounded us, rendered my eyes ſo dim, that I was ſometimes a few minutes before I could perfectly recover my ſight. I experienced no difficulty of breathing, or inconvenience from the motion of the balloon; for, though we moved with immenſe velocity, we felt not the leaſt wind or preſſure of air, it being ſo perfectly calm, that the flags in our hands, and thoſe with which the balloon was decorated, hung ſupine, nor did they ſtir.

I obſerved, that between every row of clouds, not only the atmoſphere, but the wind, varied ſeveral degrees; for, on our paſſing through the firſt cloud after leaving London, the wind, which had before been nearly ſouth-weſt, changed to ſouth-ſouth-eaſt, by which means we found ourſelves over St. Alban's, in Hertfordſhire. On aſcending ſtill higher, the wind became nearly weſt, which drove us over Epping foreſt, which I diſtinguiſhed very plainly; it appeared like a gooſeberry-buſh. I then pointed out our courſe to M. Garnerin on the map, and obſerved to him that we ſhould ſoon perceive the ſea, which in a ſhort time we ſaw very plainly. M. Garnerin then told me we had not a moment to loſe, and muſt deſcend with all poſſible ſpeed; at the ſame time pointing out a very heavy cloud to me, nearly under us; and ſaid—"Il faut que nous paſſions-à travers de ce drole la; accrochez-vous ferme, car nous allons nous caſſer le col." I anſwered—"De tout mon cœur." We then opened the valve, and we deſcended with rapidity. On ruſhing into the cloud, I found, as he had conjectured, it contained as violent a ſquall of wind and rain as ever I experienced. The attraction of the water, the force of the wind, and the conſtant emiſſion of gas from the valve, hurled us with ſuch velocity towards the earth, that I expected to ſee his prediction verified; though, I can aſſure you, my ideas at that time did not coincide with the anſwer I made him.

M. Garnerin ſtill retained all his coolneſs and preſence of mind; and, while we were deſcending with that extreme ſwiftneſs, deſired me, the moment I ſhould find the car about to touch the earth, to catch hold of the hoop which was faſtened

ened to the bottom of the net, to which the car was ſuſpended, and lift myſelf up into the net; by which means we ſaved ourſelves from being daſhed to pieces. The balloon did not reaſcend immediately, but dragged us along the ground, with aſtoniſhing ſwiftneſs, for the length of nearly three fields, before the grappling-iron took good hold: and then we thought ourſelves ſafe, being cloſe to a farm-houſe, from which ſeveral perſons came out to ſee us: but though we threw out ropes to them, and called for help, they were ſo conſternated that neither threats nor entreaties could prevail on them to come to our aſſiſtance; for, as I afterwards heard, they took us to be two ſorcerers, it being rather an unuſual thing to ſee two men coming down poſt haſte from the clouds. We were for about three minutes in that ſituation, till another guſt of wind broke our cable, and we aſcended again nearly 600 feet.

In the buſtle of preparing the ropes for the farmers, M. Garnerin had let the rope belonging to the valve ſlip out of his hand, by which means the bottom of the balloon was preſſed upwards by the wind. M. Garnerin deſired me to try to regain it; which I at laſt effected by climbing up into the net, though the force of the wind ſtruck the tin tubes faſtened at the bottom of the balloon, and through which the rope led, with ſuch violence againſt my face, that it had nearly ſtunned me. Having recovered it, we redeſcended, but were borne with ſuch violence acroſs the country, ſometimes along the ground, ſometimes in the air, that I ſeveral times propoſed to M. Garnerin to abandon the balloon, and to ſave ourſelves: but he continually objected to it, and reminded me of my promiſe not to quit him. In the mean time we were daſhed againſt ſeveral trees, one of which had nearly deſtroyed us: being with my back towards it, I received a blow on the head, which threw me at full length at the bottom of the car. M. Garnerin, in attempting to aſſiſt me, was nearly thrown overboard; two of the cords that held the car broke, and at the ſame time ſome of the branches tore the balloon: upon which M. Garnerin cried out, "The balloon is torn, and we are ſaved." Another guſt of wind diſengaged us from the tree, and we touched the ground once more, with a leſs violent ſhock than before. We then both got out, but ſo exhauſted with our numerous exertions that we had hardly ſtrength to follow the balloon, which fell again about 200 paces further; when we completely maſtered it, by throwing ourſelves upon it, and by that means preſſing out the remainder of the gas.

It rained ſo very hard, that I propoſed to M. Garnerin to leave the balloon in the field, and go in ſearch of ſome houſe

for ſhelter and refreſhment. We accordingly made the beſt of our way to a houſe, which we eſpied about half a mile off, belonging to a Mr. Kingſbery: and here a very curious miſtake took place. When we inquired for the maſter of the houſe, Mr. Kingſbery appeared: but, ſeeing two perſons of ſo ſtrange an appearance, (M. Garnerin having a French hat on with the national cockade, bearing the tri-coloured flag, and myſelf being in a ſailor's dreſs, with the union jack in my hand,) he imagined we came on account of the election; and, before we could addreſs him, ſaid, "Gentlemen, though I am a freeholder, I have made a determination not to vote for one ſide or the other." So much was he impreſſed with this idea, that it was ſome time before we could make him ſenſible that we had nothing to do with the election, but that we came in a balloon, in three quarters of an hour, from London; that we were very much bruiſed and tired, and that we required his aſſiſtance and ſhelter. He then received us in the moſt hoſpitable manner, not only providing us with refreſhments and dry clothes, but even offered us beds, the uſe of his houſe and horſes, and ſent immediately ſome farmers with a cart to carry the balloon from the field and convey it to a place of ſafety; and, as we expreſſed a wiſh to get to Colcheſter that night, he ſent for a poſt-chaiſe to convey us thither, where we were received with loud acclamations by the inhabitants. The next day we returned to Langenhoe, where we had left the balloon, and, after drying it on the graſs, packed it up, and made the beſt of our way to town, where we arrived about four o'clock the next morning.

I cannot help admiring the coolneſs and preſence of mind M. Garnerin preſerved even in the moſt imminent danger; and I am ſo confident of his great talents and ſkill in conducting a balloon, that I would venture to go to the end of the world with him.

This is as near a ſtatement as I can recollect; and I ſhould take it as a favour if you would inſert it in your Publication, as you will thereby ſave me a great deal of trouble, having hardly breath enough to anſwer the numerous inquiries concerning our aërial excurſion. I am, Sir, yours, &c.

R. C. SOWDEN.

The ſecond Voyage.

M. Garnerin was accompanied in this voyage by Mr. Locker, who gives the following account of it:

Although the world has been already preſented with an account of a late aërial excurſion, I flatter myſelf ſo much intereſt

tereſt is ſtill entertained by the public for the ſafety of M. Garnerin, that the following particulars of his ſecond aſcent will prove acceptable. The very unfavourable weather, attended with a heavy gale at ſouth and ſouth-weſt, induced M. Garnerin to give up his intention of aſcending to diſplay the promiſed experiment of the parachute. In this event, it had been arranged that Mr. Sowden ſhould once more accompany him; but ſome miſunderſtanding having taken place between thoſe gentlemen, and having had ſome previous converſation on the preceding day with M. Garnerin on the ſubject, I aſcended with him yeſterday afternoon at ten minutes before five o'clock from Lord's Cricket-ground. The ſtrong aſſurances of my companion, added to what I had read on the ſcience of aëroſtation, and the experience of former aëronauts, had ſo fully perſuaded me of my perfect ſecurity, that I enjoyed the wonderful and enchanting proſpect which now preſented itſelf with unmixed pleaſure. Although the denſe ſtate of the atmoſphere obſtructed the ſight of diſtant objects in ſo great a degree that our horizon was ſomewhat limited, the unuſual concourſe of ſpectators, which gradually diminiſhed to an undiſtinguiſhed maſs, and the view of a great part of the metropolis, together with the ſurrounding country, afforded me an entertainment well worth the purchaſe of any ſuppoſed danger. After throwing out ſome part of our ballaſt we aſcended very rapidly, and by the intervention of ſome thick clouds (which had much the appearance of a ſea of cotton beneath us, as deſcribed by Mr. Baldwyn, of Cheſter), we entirely loſt ſight of the earth. We moved with much rapidity, although our motion was to me perfectly imperceptible; and at length the clouds diſperſing, we again ſaw the country below us. I attempted, in vain, to aſcertain our ſituation, by calling to my recollection the appearance of the country, which appeared to me more like a proſpect ſeen in a camera, when placed in a very elevated ſituation, than any thing to which I could compare it; I think a map is an incorrect compariſon, as the various objects are not, as in nature, delineated with ſufficient minuteneſs to bear ſuch a reſemblance.—About this time M. Garnerin looked at his watch, and, obſerving we had been five minutes on our voyage, propoſed to deſcend in about the ſame time.

The peruſal of Mr. Sowden's narrative led me to obſerve, with much attention, the power of hearing noiſes below. Neither M. Garnerin nor myſelf could diſtinguiſh ſounds above the elevation of 3 or 4000 feet; though M. Garnerin

imagines a very confuſed ſound, but totally undiſtinguiſhable, may be heard conſiderably higher. We never attained a greater height this day, by M. Garnerin's computation, than about 1200 French toiſes, or 7800 feet, as M. Garnerin, being deſirous to return the ſame evening to town, did not chooſe to loſe a favourable opportunity of deſcending. At length we ſaw at a diſtance what afterwards proved to be Epping foreſt, with a range of diſtant hills beyond; and obſerving an open champaign country, M. Garnerin opened the valve, and we began to deſcend. He directed me to call to ſome perſons employed in a field, as we approached the ground, to take hold of the ropes which we had thrown out for the purpoſe, and recommended me to hold faſt by the cords, to avoid the ſhock on the balloon's firſt touching the earth. This precaution proved very neceſſary, as the force with which we deſcended was very conſiderable, from the force of the wind rather than by our ſpecific gravity, and the rebound bore us up again with velocity to the height of 150 or 200 feet. In redeſcending we ſtruck againſt a tree, the ſhock of which gave M. Garnerin a ſevere blow on the back; and he obſerved that this was the only occaſion, during a period of twelve years in which he had been in the habit of aëronavigation, and the 27th time he has aſcended, that he ever ſuffered ſuch an inconvenience. Several of the peaſantry being now at hand, we were prevented from any further aſcent, and alighted from the car with perfect ſafety. We immediately inquired our ſituation, and found we had fallen in a field of Mr. Owen's, at Chingford, in Eſſex; and, referring to our watches, obſerved we had made our voyage exactly in one quarter of an hour. We diſpatched a meſſenger to Woodford for a poſt-chaiſe, and, having expreſſed the inflammable air, packed the balloon in the car, and had it conveyed to a ſmall inn at Chingford-green, adjoining which we had deſcended; from whence, after a ſlight repaſt on ſome proviſions we had brought with us, we ſet off for London, and arrived at M. Garnerin's, in Poland-ſtreet, a quarter after nine in the evening.

Although the mob, which ſurrounded us on our deſcent, were, as uſual, both troubleſome and officiouſly impertinent, we received great attention from Mr. Hughes, of the Stamp-office, London, and ſeveral other gentlemen, who beheld our arrival. Attention would have been, however, inſured to us, if neceſſary, by the paper put into the hands of M. Garnerin, ſigned by his royal highneſs the prince of Wales, the ducheſs of Devonſhire, lords Beſborough, Cathcart, and other perſons

of

of diſtinction, who witneſſed our aſcenſion at Lord's Cricket Ground. I am, &c.

Greenwich, July 6. ED. HAWKE LOCKER.

(COPY.) July 5, 1802.

"We, the underſigned, having been preſent at the aſcenſion of M. Garnerin with his balloon this afternoon, and witneſſed the entire ſatisfaction of the public, beg leave to recommend him to the attention of any gentleman in whoſe neighbourhood he may happen to deſcend.

George, P. W. Beſborough. R. Ford."
G. Devonſhire. Cathcart.

M. Garnerin's balloon aſcended at Lord's Cricket Ground, London, at ten minutes before five, and deſcended at Chingford-green, in Eſſex, in a field of Mr. Owen's, at five minutes paſt five, paſſing a diſtance of nine miles in one quarter of an hour: this circumſtance atteſted at the King's Head, Chingford-green, in the preſence of

George Clinton Davies, Thomas Williams,
John Hughes, Stamp-office, London; George Soames,
John Odtrins, Richard Pamphilion.
Garnerin,
E. H. Locker, } The aërial travellers upon this occaſion.

We believe Mr. Locker means to publiſh a fuller account of his voyage.

VOYAGES AND DISCOVERIES.

C. Riedlé, gardener to the expedition under Capt. Baudin, has addreſſed the following letter to C. Thouin, profeſſor in the National Muſeum of Natural Hiſtory:

"Iſland of Timor, September 28, 1801.

"We left the Iſle of France on the 25th of April laſt. Our paſſage to Lewin's Land, New Holland, was thirty-two days. Scarcely had we arrived on the coaſt, when the currents drove us to the diſtance of more than ten leagues. We, however, ſucceeded in approaching it, and coaſted along it for ſeveral days at the diſtance of about two leagues without obſerving a ſingle place where we could land in ſafety with the boat. The whole coaſt is bordered with reefs: it preſents a barren aſpect, and nothing is ſeen but ſmall buſhes amidſt white ſand. But, when we reached the latitude of Point North, we diſcovered a vaſt bay, the entrance of which appeared to be at leaſt fifteen leagues in breadth, and which penetrates more than ten leagues inland. It was called the *Baye du Geographe**.

"We anchored in this bay on the 28th of May. The firſt care of our commandant was, to diſpatch an officer to ſound it, and conſtruct a chart of it. I obtained leave to go in the boat. We landed at a place bare of wood, but ornamented with a great variety of plants. I much regret that I was able to remain here only a few moments.

"Next day we hove up our anchor in order to take a ſta-

* This is the name of the commodore's veſſel.

tion at the bottom of the bay. A great part of the crew went on ſhore; and here, for the firſt time, we had an opportunity of ſeeing the natives of the country.

" The ſhores of this bay, thoſe at leaſt which we were able to explore, preſent in general only downs, or ſmall hills of ſand accumulated by the wind. Some ſhrubs grow here, but thinly ſcattered, and the largeſt are not ſix feet in height. Beyond theſe are low grounds covered with thick woods. Among theſe, in particular, is diſtinguiſhed a kind of juniper. Theſe beautiful trees retain their foliage throughout the whole year, grow very clo e to each other, and, as their tops all riſe to the ſame height, hey appear to the eye which views them from the top of the downs like large ſheets of verdure extended horizontally and attached to different trees which ſurround them. Their bark, which is exceedingly thick, and five or ſix lines in thickneſs, is employed by the inhabitants for covering their huts, to make dreſſes to ſecure them from the cold, and as beds to ſleep on.

" The upper part of the ſoil conſiſts of a ſtratum of vegetable earth, of the colour of turf, at leaſt ſix inches in thickneſs. Below is found very black moſs earth. I collected ſome of it as a ſpecimen.

" This day I obtained ſeveral beautiful plants, among which were a *gnaphalium*, with large flowers as white as ſnow; and an *atriplex*, with larger and longer leaves than thoſe of the bay laurel. I met with others which were not new to me, and I even ſaw ſome which grow in the neighbourhood of Paris. Our excurſion ended with the day, and it was night-fall when we returned on board.

" It was intended that we ſhould ſail from the bay next morning; but the officers of the *Naturaliſte**, who had landed on a different part of the coaſt, having reported to the commodore that they had diſcovered a kind of river, it was determined that the long boat and a canoe ſhould be ſent to explore it. Every body wiſhed to be of the party: the botaniſt, the mineralogiſt, the doctor, the commodore's ſecretary, and myſelf, were admitted.

" This day was a day of misfortune. I had made a rich collection of plants, and was returning loaded with them to the landing-place, when I learned that the boat had run aground, and that it was impoſſible to get it afloat again. The canoe ſet out alone at ten in the evening, and the officer who had charge of it promiſed to uſe the utmoſt diſpatch to inform the commodore of our diſagreeable ſituation.

" The number of perſons on ſhore being ſixteen, we made

* The other veſſel belonging to the expedition.

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an intrenchment around us, lighted a large fire, and appointed a guard of three men to keep watch during the night. Next day paſſed away without hearing any news from the ſhip. The day following ſtill nothing was ſeen. The ſea, however, appeared to be viſibly rougher, and to become more and more threatening. We began to be in want of proviſions and water. At laſt, on the third day, we ſaw a boat coming from the *Geographe*, which brought us all the aſſiſtance we ſtood in need of. We learned, that the one which carried to the commodore the news of our diſtreſs had been thirty-ſix hours in reaching the veſſel, having had to ſtruggle againſt a very hollow ſea; that the barometer had fallen more than ſix lines in the courſe of a very ſhort time; and that every thing announced a violent ſtorm. The commodore requeſted us to haſten our embarkation; and to leave on ſhore our arms and ammunition, together with all our baggage, and even all the plants which I had carefully collected, and for which there was no room in the canoe. It was juſt time: two hours later we ſhould not have been able to reach the ſhip: it would even have been impoſſible to embark.

"A canoe having been diſpatched from the *Naturaliſte* to recover the effects we had left on ſhore, one of the ſailors, an excellent ſwimmer, threw himſelf into the ſea to tow it on ſhore; but, being thrown down by the waves, he ſunk and diſappeared. The canoe returned without landing, and brought back nothing but the melancholy intelligence of the loſs it had ſuſtained.

"We were three days in getting from this bay. The day after, the *Naturaliſte* ſeparated from us; and we did not ſee her again till ſhe reached Timor, a month after our arrival at that iſland.

"After we left the bay, and when the bad weather was over, we approached the land, and ſtretched along the coaſt as near to it as poſſible. Never in my life did I ſee a country more arid or barren: not a drop of good water to be got; little or no vegetation; and the land inacceſſible, and ſurrounded by reefs and deep water. Sometimes, when at the diſtance of ſix leagues from the coaſt, we had thirty-ſix fathoms water, and in a few minutes we found only five.

"In this manner we reached the *Baye des Chiens Marins*, where the veſſel anchored. During the time we ſtaid here I had an opportunity of viſiting two iſlands, which may be each twelve or fourteen leagues in extent. I traverſed them nearly in every direction, obſerving with great care their natural productions, particularly the plants, ſeveral of which were

were unknown to me. I collected ſeventy ſpecies. It was then I regretted that I had not been able to land on different points of the immenſe coaſt along which we had ſailed. Notwithſtanding its appearance of ſterility, what a ſtore of hidden curious and unknown productions it would have preſented to me!

"On our departure from the *Baye des Chiens Marins* we diſcovered a new iſland, which we marked on our chart. We called it *l'Iſle des Amiraux*, becauſe we ſaw a great many birds of that name upon it. This iſland is about three leagues from the land. Notwithſtanding the good intentions of the commodore, it was not poſſible for any of the naturaliſts to go on ſhore; but the officer ordered to reconnoitre it brought back ſeveral beautiful ſhells and plants. He obſerved alſo a quadruped of the ſize of a ſhepherd's dog; and diſcovered a ſpring of excellent water.

"We continued our voyage along the coaſts of New Holland, but no where went on ſhore. At length, after a moſt diſmal navigation, we anchored, on the 23d of Auguſt, in the harbour of Coupant, in the iſland of Timor. On the 25th we took up our lodging on ſhore in two houſes provided by the governor for the commodore: the latter reſides in one of them, and the naturaliſts in the other.

"How great a contraſt this fertile and woody country, eſpecially in the part which we inhabit, forms with the coaſts we have juſt ſailed along! The plants, indeed, are not ſo uncommon as thoſe of New Holland. A great many of them are cultivated in the Iſle de France. I have ſeen the wild bread-fruit tree, mango trees, and tamarind trees of a prodigious height, areca trees, cocoa-nut trees of different kinds, the maringa, ſophara, &c. The whole country around the harbour of Coupant is covered with theſe beautiful trees. I have ſeen fig trees thirty feet in circumference, ſhading the ground to a great diſtance with their branches, and capable of ſheltering from the rain a whole battalion of ſoldiers. I found the *rizophora mangas*, which I had before obſerved in America; but the tree which appeared to me moſt remarkable was the *caſuarina*, the trunk of which grows to the ſize of ten feet in circumference, and riſes to the height of fifty.

"This iſland is watered by a multitude of ſtreams: it contains beautiful plains, which are eaſily laboured with the plough. The principal objects of cultivation are rice, maize, yams, and tobacco.

"I have already made a great many herborizing excurſions in the iſland. In drying the plants for the *hortus ſiccus*, I do not forget to preſerve living ones, to be conveyed to the

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Iſle of France, and perhaps to Europe. I ſhall leave them at Timor, to which we intend to return when we have explored the ſouth part of New Holland. I have little hope of bringing back many from that ſtrange country. The commodore has already informed me that it is almoſt impoſſible to carry on board living plants on a coaſt ſo dangerous, and to ſtow them in a veſſel where ſo much room is required for performing the multiplied manœuvres rendered neceſſary by the increaſed danger.

" I think we ſhall leave this place about the end of the month in order to explore the ſouth coaſt of New Holland."

The court of Madrid has determined to ſend out two *ſçavans* to make diſcoveries in the interior of Africa. They are now at Paris, but are to viſit this country for the purpoſe of purchaſing mathematical and aſtronomical inſtruments. They wiſh alſo, previous to their departure, to have an opportunity of conferring with the African Society, and of ſeeing Mungo Parke, who is ſo eminently qualified to give them that previous information which may enable them to proſecute their reſearches with ſucceſs.

ANTIQUITIES.

The prefect of the department of the Côtes-du-Nord having ordered ſome reſearches to be made by digging in the village of Courſeult, two leagues from Dinan, the workmen employed came to the ruins of a buried city, reſpecting the exiſtence or deſtruction of which no traditionary accounts are preſerved. Several antiquaries are of opinion that it was the antient capital of the Curioſolites, the name of which is ſtill preſerved in the corrupted appellation of Courſeult. Several highways, the pavement of which is in good preſervation, end at this village, and proceed in the following directions: one towards Rennes, another towards Vannes, a third towards Coutances, and a fourth towards the ſea. A quantity of walls, of greater or leſs thickneſs, have been found, which, no doubt, formed the houſes and ſtreets of the town; ciſterns; the half of an octagon temple; a great many medals of Nero, Tiberius, Fauſtina, Conſtantine, and others, with ſmall bronze figures. There is reaſon to hope that more important diſcoveries will be made to decide the uncertainty which prevails among the learned in regard to the exiſtence of this antient town.

In our eleventh volume we informed our readers that M. Von Hammer among other intereſting objects had diſcovered and got poſſeſſion in Egypt of an Arabian MS. of great antiquity,

antiquity, which would probably furniſh a complete key to the hieroglyphics. We are now able to ſtate ſome further particulars reſpecting this invaluable acquiſition. The title of the work is, "The wiſhed-for Object in regard to the Secret of the Alphabets," collected in the time of the caliph Merwan by a man of learning, who at that period was much employed in tranſlating Syriac and Chaldaic books into the Arabic. The name of the author is Achmed Ben Abubeker Ben Wahſchize. It contains eighty alphabets; ſome of them known, ſome unknown; ſome of them now in uſe, and ſome of them employed in the eaſt for writing in cyphers: and, at the end, three tables of hieroglyphics with an explanation added to them in Arabic, and which is founded on principles more agreeable to truth than could be expected from an Arabic work on the ſubject. The gentleman who found this manuſcript had it tranſlated into Engliſh on his arrival from Egypt; and Mr. Nicol, the bookſeller, known by his zeal for the progreſs of every thing that tends to promote the cauſe of literature, has, we underſtand, undertaken to publiſh the original and tranſlation at his own expenſe. The unknown alphabets are to be cut in wood, and the text will be printed with a new letter which exceeds in elegance any thing of the kind ever before produced in oriental types. This work will be ready, it is ſuppoſed, in the courſe of the preſent year; and, with Zoega's new work on obeliſks, and the works to be publiſhed by the Society of Antiquaries on the ſtone with three inſcriptions, in the hieroglyphic, vulgar, and Greek language, will, in all probability, throw great light on this ſubject, not yet ſufficiently explained.

MAMMOUTH.

The following is an extract of a letter on this ſubject from C. Roume, private agent of the French government at Saint Domingo, dated Philadelphia, January 4, 1802:

"Mr. Peale, that indefatigable naturaliſt, whom the Americans have the happineſs to poſſeſs without knowing his merit, has diſcovered ſeveral ſkeletons of the mammouth, one of which is entirely complete except a few of the double parts; but drawings of the parts which are wanting have been made from thoſe that remain. He has taken the greateſt care to mount this ſkeleton, and yeſterday it was publicly exhibited.

"The firſt day, however, was deſtined only for the members of the Academy of Arts and Sciences at Philadelphia; and I ſhould not have been able to pay a viſit to this antient inhabitant of America had it not been for the politeneſs of Mr. Peale, who admitted me into the exhibition-room, with ſeveral

ſeveral Frenchmen who accompanied me, and particularly C. Fouſſenguy.

" The latter, then, can tell you, that the ſkeleton of the mammouth does not ſenſibly differ from that of the Aſiatic elephant but by ſome particularities in the teeth and tuſks. The maxillary teeth of the elephant touch each other in ſurfaces not very unequal; while the upper ſurfaces of the teeth of the lower jaw, and the inferior ſurfaces of the teeth of the upper jaw, in the mammouth, are furniſhed with very prominent and pretty ſharp tubercles.

" The tuſks of the elephant have only one curve, while thoſe of the mammouth have a double curve. They firſt iſſue from the upper jaw more divergent than thoſe of the elephant; they then turn ſo as to form part of a ſpiral, deviating more and more to the left. In a word, ſetting aſide the double curve, and conſidering each tuſk in profile as if it were traced out on the ſame plane, the whole of the curve of the tuſks of the mammouth is rounded much more; that is to ſay, preſents an arc of a great many more degrees than that of the elephant.

" Had a ſkeleton of the elephant been placed by the ſide of the preſent one, I ſhould, perhaps, have been able to remark other differences; but theſe were the only ones it was poſſible for me to obſerve.

" Mr. Peale is going to mount a ſecond ſkeleton of the mammouth, but much leſs complete: he intends to commit it to the care of his ſon, who will exhibit it in the principal cities of Europe, in order to obtain money to maintain his family, and to enable him to continue his reſearches, which may lead to other diſcoveries no leſs intereſting, ſince it is now fully proved that there exiſted formerly in America another animal ſtill greater, perhaps, than the mammouth. This proof reſults from ſome maxillary teeth and boney fragments, which have nothing in common with the ſame parts in the mammouth, and which are formed on a much larger model.

" I beg you will communicate theſe details to the National Inſtitute. Get Mr. Peale choſen a correſponding member. You will not repent it. I have already prevailed on him to ſend his ſon firſt to France; and I have promiſed that you will give him a good reception, and preſent him to the Inſtitute, who certainly will not fail to induce the firſt conſul to purchaſe the ſkeleton which Mr. Peale jun. will bring with him, either that it may be depoſited in the National Muſeum immediately, or after he has been allowed to exhibit it in different parts of Europe. The ſkeleton which

has been mounted is 11 feet 9 inches Engliſh in height from the extremity of the vertebral epiphyſes of the ſhoulder to thoſe of the fore-feet."

STATISTICS.

C. Chaptal has ſent the following letter to M. Otto, miniſter plenipotentiary of the French republic at London, in conſequence of receiving, through his hands, a copy of Sir John Sinclair's paper on longevity, a part of which has been given in the preſent number of the Philoſophical Magazine:

"I beg you will thank Sir John Sinclair for the work he has ſent me: it is worthy of a man who is conſtantly employed with what is uſeful, and who has directed his attention to one of the moſt curious and moſt intereſting points in the ſtudy of man. Anſwers to the queſtions propoſed by Sir John Sinclair would, no doubt, throw great light on the cauſes, hitherto obſcure, in regard to the difference in the duration of the life of man. We ſee ſome placed in circumſtances which might be conſidered favourable, carried off at a very early age; while others, ſurrounded by all the apparent cauſes of death, reach the utmoſt term of human life. I ſhall circulate the queſtions propoſed by Sir John Sinclair, and I have given orders that the tables of mortality drawn up by the government ſhall be tranſmitted to him every year, with the particular obſervations which accompany them. I ſhall be very glad to know his opinion on this labour as it reaches him. I beg you will aſſure him of my eſteem, and that I wiſh a correſpondence may be eſtabliſhed between us."

MEDICINE.

In a letter which came to hand a few days ago from our friend Dr. Mitchell, of New York, whoſe political engagements (having been again elected member of Congreſs) have not leſſened his ardour for ſcience, we have received ſeveral important communications, which ſhall appear in our next. We ſhould, however, feel ourſelves culpable if we delayed the publication of the following caſes of pulmonary conſumption cured by a ſalivation; communicated in a letter from Dr. Ruſh to Dr. Miller, dated Philadelphia, May 6, 1802:

"I have great pleaſure in informing you that Dr. Parke has lately diſcharged a patient from the Pennſylvania hoſpital perfectly cured of a pulmonary conſumption by means of a ſalivation. I have likewiſe been again made happy in ſeeing the triumph of that remedy in the caſe of Mr. James Hunter, a young gentleman of reſpectable character in this city. He had been afflicted for ſeveral years with weak lungs; and, in conſequence

conſequence of an attack of the bilious fever laſt fall, became diſeaſed with all the uſual ſymptoms of a confirmed conſumption. The ſalivation was adviſed by Dr. Phyſick and myſelf, and was continued to a ſevere degree for ſeveral weeks. His cough and fever left him with the ceſſation of the diſcharge from his ſalivary glands. I ſaw him on the ſecond of this month in good health, and with a conſiderable increaſe of fleſh ſince his recovery.

DEAFNESS RELIEVED BY GALVANISM.

Profeſſor Pfaff, of Kiel, in a letter to Dr. Friedlander, at Paris, ſays: "There is an inſtitution for the deaf and dumb at Kiel. For three weeks paſt I have employed the electric pile of Volta as a cure for deafneſs. It produces its effect very ſlowly. The letters which the deaf and dumb can hear, as we may ſay, ſerve as a meaſure to determine the degree of their deafneſs. They hear the letter *a* the ſooneſt, then *e*, and in the laſt place *i*. They often change *o* into *u*: One of them heard *ou* for ſome days as *u*. Of all the conſonants, *r* is that which they hear firſt. They are ſoon able alſo to hear *ſs* and *ch*; but they do not hear *l* and *s* till very late. The ſame phænomena are obſerved in ſeveral individuals at the ſame time. It appears, however, that the Voltaic pile produces only a momentaneous irritation of the auditory nerves during the time it is employed, and that this irritation is followed by a weakneſs and relaxation of the parts. The patients became deaf as before when I ceaſed to electrify them, for the effect is nothing elſe than that produced by electricity. I propoſe to continue my experiments for two months at leaſt.

DEATH.

On the 28th ult. at his houſe in Marlborough-ſtreet, in his 35th year, Thomas Garnett, M. D. of a fever of the typhous kind. Without anticipating the account of his life, which, we underſtand, is to accompany his lectures, many of which he left ready for the preſs, we may obſerve, in general, that he poſſeſſed all the eſſential qualifications of a public teacher, in an eminent degree. Having been early initiated in claſſical and mathematical learning by a gentleman of uncommon ability, eſpecially as a geometrician, he was thus regularly prepared for his ſubſequent courſe of ſtudy at Edinburgh; where his application was ſuch, that we have heard him ſay, he allowed himſelf, for ſeveral years, only four hours ſleep, and very little relaxation during the day. What muſt have been the progreſs of a penetrating genius, combined with

ſuch induſtry, and under the conduct of able teachers, (whom, by the way, he always mentioned with the greateſt reſpect,) our philoſophical readers will eaſily conceive. In fact, when the doctor left that univerſity, he might be ſaid to have been accompliſhed in all the eſſential parts of medical erudition, and thoroughly initiated in every collateral branch of knowledge. He had made himſelf well acquainted with the theory of the celebrated Brown; and the ability with which he ſupported that theory is well known to the readers of his Lecture on Health, and will be ſtill more apparent when his Lectures on Zoonomia, of which he left a correct copy, come to be laid before the public. He gave a decided preference to the modern chemiſtry, which he treated with all that perſpicuity and preciſion, which might be expected from a teacher who had been early habituated to the cloſe and accurate reaſoning which diſtinguiſhes the mathematical ſciences. We have heard him ſeveral times ſay that, in point of evidence, chemiſtry, in its preſent ſtate of improvement, is not inferior to the Newtonian philoſophy: and although we might not be prepared to give our unqualified aſſent to this opinion; yet we cannot but acknowledge that ſuch a declaration, from ſo able a judge, is highly creditable to the ſcience. As an experimenter, Dr. Garnett was at once dexterous and cautious; ſo cautious, indeed, that we never knew or heard of any material accident happening at his lectures. His audience attended him with a ſenſe of perfect ſecurity, and his apparatus ſuffered little or no damage in his hands. Many of the articles were improved by the alterations he had occaſion to make in them; and, upon the whole, his apparatus, as it now ſtands, is extremely valuable. We apprehend it will be diſpoſed of by private ſale, which, however judiciouſly conducted, cannot be expected to return any thing like its original coſt. This is the more to be lamented, as upon that apparatus, the lecture-room which he lately built, and the many contingent expenſes attending a new eſtabliſhment, the doctor had expended ſo much money, as to have left little or no proviſion for his orphan children. A ſubſcription, we underſtand, is to be opened in their behalf, which, we hope, will place them in a ſituation in ſome degree ſuitable to the proſpects they might reaſonably have entertained, if their father had lived to reap the fruits of his labours.

XXXV. *On Painting.* By Mr. E. Dayes, *Painter**.

Essay III.

On the Elements of Beauty.

What art thou, Beauty? whence thy pow'r,
That thus perſuaſive charms the heart,
When thy fair hand adorns the roſeate bow'r,
Or blooming virgin, pride of all thy art!

Langhorn. *Vide Grand Magazine.*

UPON mature conſideration it will appear as if our inquiry ſhould be after the beautiful itſelf; or, in other words, that which makes every thing beautiful by its preſence. For, ſhould any one aſſert that beauty is purely external, he muſt never have conſidered the ſubject. For, were it aſked from whence a man is wiſe, ſhould we not anſwer, From poſſeſſing wiſdom? And ſhould we not ſay the ſame of good things, that they were ſo from having good in them, and that an object is beautiful from poſſeſſing beauty? or ſhall we pronounce thoſe things mere non-entities, and the words of no import?

Perhaps any two perſons in oppoſite hemiſpheres, who ſhould begin or invent a ſcience (geometry for inſtance), would proceed in their diſcoveries nearly in the ſame way. Now, to invent is to find; and to find ſomething preſuppoſes its exiſtence ſomewhere, internally or externally, ſcattered or in a maſs. Or ſhall we ſay there is not any ſuch thing as ſcience? that it is only a knowledge of externals? But how could they aſſert the power of that Being who operated prior to all externals? If our knowledge is of externals, we muſt certainly labour under a deception; for it is not externals but their images only that we are acquainted with, the objects themſelves not becoming the ſubject of ſpeculation. So we ſhall not poſſeſs truth itſelf, but only certain images of truth, and of courſe poſſeſs what is falſe; while truth will abide in the externals. Hence ſhould we not rather conclude that ſcience cannot be taught by man, or be obtained through the means of externals only, but lies, as it were, latent in every mind, till excited and brought to light by diligent and deep inquiry? For, were the inquiries of art after viſible objects, the point would ſoon be ſettled by diligently copying the images painted to ſenſe: on the contrary, the artiſt, recurring to the reaſoning energy, aims at a perfection

* Communicated by the Author.

beyond matter. But ſome, having no knowledge of internal beauty, are conſtrained to ſeek it in the objects of ſenſe, and of courſe preſent us with all the imperfections of an individual model. Hence, was beauty to remain external to the ſoul, it could never affect; but, being well and perfectly conceived, we are moved by it with the moſt exquiſite delight.

Painting depends on two powers, the mind and the hand; or, in other words, reflection and practice. We ſhould therefore, by an early application to drawing, particularly regular forms, qualify ourſelves to embody our ideas with facility and eaſe when the mind has attained to maturity.

As the Great Firſt, or that which is in the moſt exalted degree, contains all things in the immenſity of his being; ſo all things being referred to and ſubſiſting by him, he is conſidered as the good of the univerſe. Hence all deſire the poſſeſſion of good, as thinking thereby they ſhall become ſufficient to themſelves *. But all do not think the poſſeſſion of beauty will be the completion of their wiſhes; not that the good can be deſtitute of beauty, as in the Firſt muſt neceſſarily abide all things: ſo it will be ſuperior to beauty, as not requiring the aſſiſtance of the ſenſes.

The beauty of intellect is ſuperior to that of matter, and appears to have had a previous exiſtence; juſt as the concluſion will remain indubitably certain, whether the ſyllogiſtic energy be exerted or not; or as true ſcience exiſted before theory, and it before practice †. It is from this the artiſt can never faſhion beautiful forms equal to the perfection of reaſon from which he acts; for reaſon is a ſuperior beauty, ſince in it is contained the beauty of art.

Again, as beauty argues perfection, it were in vain to ſeek it in ſenſibles, the objects of ſenſe being imperfect. For, though we ſhould grant it is rendered in a certain degree viſible in matter, yet the higher degree of perfection is implied in the Venus Urania.

To carry on our inquiry, works of art cannot derive their beauty from the materials of which they are compoſed, but from the *reaſoning energy*; not becauſe the artiſt poſſeſſes hands and eyes, but that he is endowed with art. For it is

* The Supreme Author of our being has ſo formed the ſoul of man, that nothing but himſelf can be its laſt, adequate, and proper happineſs. ADDISON.

† True ſcience belongs only to the great Artificer of the univerſe: all our exertions only place us in a middle ſtation, between ignorance and perfect wiſdom. It is ſcarcely neceſſary to obſerve, creation could not have been produced through the means of externals, as ſenſible objects had not then a being. It may be further neceſſary to remark, that the wiſe of all nations have thought that the ſciences have vaniſhed and appeared again under the various revolutions of the univerſe.

the

the duty of the artiſt to faſhion beautiful forms; as of a man, not any particular one is to be taken as a model, but he is bound to enter into the reaſons of art, and produce a perfect aſſemblage of beauty.

Something further than manual labour is neceſſary, otherwiſe we may miſtake ſeeing and hearing for underſtanding.

Some ignorantly miſtake magnitude for greatneſs; but if bulk is beautiful as bulk, it muſt follow that active reaſon, which is not bulk, is not beautiful. But the contrary is the fact, and fine works of art derive their excellence from reaſon infuſed and exiſting in matter.

It is from miſtaking the true end of art that many fall into painting large pictures, ſuppoſing what is big muſt alſo be great in art; whilſt others, from an exceſs of vanity, give their figures a gigantic proportion—highly improper in what may be termed *chamber pictures*. Wrong or bad taſtes delight in things monſtrous. The exceſs of Nero was ſhown in his ordering a picture of himſelf to be painted on cloth 120 feet high, which was ſet up in the gardens of Marius; in his golden palaces; and in his gilding ſome fine ſtatues *.

The love and admiration of beauty is implanted in our natures by the great Firſt Cauſe, and we are carried to it by an impulſe irreſiſtible; its influence is powerful; it tranſports the ſenſes beyond what is uſual, and, if its continuance be long, is accompanied with melancholy, and a ſilent ſadneſs.

> ——————She never told her love,
> But let concealment, like a worm i' the bud,
> Feed on her damaſk cheek: ſhe pin'd in thought,
> And, with a green and yellow melancholy,
> She ſat like Patience on a monument
> Smiling at Grief. SHAKSPEARE.

Though the above is one of the effects cauſed by beauty, yet we wiſh to be underſtood as diſtinguiſhing between the ſatisfaction we feel upon contemplating any thing beautiful, of whatever kind it may be, and that paſſion of the mind ariſing from deſire or luſt.

Many definitions of beauty have been attempted. Johnſon calls it "that aſſemblage of graces or proportion of parts which pleaſes the eye." Locke, "a certain compoſition of colour and figure, cauſing delight to the beholder." A third, "perfection." The two former appear to come much nearer truth than the latter; for, if beauty was perfection, the toad muſt be beautiful, it being equally perfect with the reſt of creation.

* I think it was Caligula that deteſted the works of Virgil, and lamented he did not live in his time, that he might have had the *pleaſure* of putting him to death.

Fancy or opinion will go but a little way towards illuſtrating a ſubject that ſeems to influence on ſome univerſal principle, and to affect all perſons, and at all times.

It appears pretty generally admitted that beauty (or the beautiful) is that which moves us with pleaſure through the ſight or hearing, as by the eye we are delighted with pictures, ſtatues, or buildings; and in muſic, with the harmony of well meaſured ſounds; alſo in poetry, with ſentiment and meaſure: but as whatever is produced by nature or art is the effect of a certain wiſdom, hence it follows that wiſdom becomes one of its qualities, and the faſcinating power of beauty will appear to ariſe from an union the moſt delightful—wiſdom and pleaſure*; which will affect all perſons, and at all times, and will equally apply to painting, ſtatuary, poetry, ethics, and laws.

We muſt not conſider apparent beauty as a ſimple idea, or as exiſting in proportion, ſhape, ſoftneſs, &c. only; one conſtituent is colour, and, in a more abſtract way, light and ſhade; for on the latter being well diſpoſed depends much of the general good effect of the picture, as from a bad diſpoſition of the light and dark a fine form may be defaced and broken.

Many imagine the arts operate by imitating nature merely: the fact is, they do not ſimply copy ſuch objects as are ſeen by the eyes, but, recurring to thoſe reaſons from which the energy of nature ſubſiſts, add ſomething where any thing is wanting to the perfection of the whole. Thoſe beautiful forms of the Greeks which happily exiſt among us are not imitations of any ſpectacle proper to the ſenſes, but are the reſult of profound contemplation. Phidias, when he faſhioned his Jupiter, conceived the idea of the god ſuch as he would appear if exhibited to our eyes, and, by a divine enthuſiaſm, produced a work ſaid to be more than mortal.

It is this lovely ideal that ſtamps ſuch a value on the beſt works of art; it is this ideal perfection which may be truly called the goddeſs of painting, the light of ſcience, the fire from heaven with which Prometheus animated his ſtatues; it is the loves, the graces, of genuine and legitimate art.

On the ſenſible Qualities of Beauty.

Many reaſons have been aſſigned why beauty charms and captivates the ſenſes. The Platoniſts believed our delight

* Hence the ſtatue of Hercules as well as the Venus de Medicis will be beautiful in art from the above union; but, was the former animated, the pleaſure would vaniſh from a dread of his power.

arose from its producing a recollection of those beautiful visions we had enjoyed in a previous and more perfect state of existence. Burke calls it "some quality in bodies acting mechanically upon the human mind by the intervention of the senses."

That there is a beauty superior to form and colour is unquestionable, as light, which, though in itself formless, is a source of form, and is perhaps the only thing visible: light is life, its opposite is darkness and death.

Ignorance of beauty and taste argues a defective animation, whilst a wrong or bad one proceeds from a weakness of judgment: hence some mistake deformity for beauty, and continue in that error through life. The young artist should therefore learn as early as possible to avoid gross and vulgar habits if he proposes to elevate the character of his works: if his apostles appear as if strayed from Rag-fair, and his heroes and princes possess the vulgar air of prize-fighters, they can never be expected to interest beyond people of similar habits, and will never attract the attention of those whose sentiments are delicately just: coarse intelligence may surprise the unthinking, but will not satisfy the discerning.

Mild, affable, and gentle, are qualities of beauty, and these we admire when we see them united (in temperance) with the three principal signs of life—heat, motion, and voice; but excess of either destroys.

There are three distinct characters of beauty, two of which may be considered as earthly; as the common, which depends on fashion, and satisfies common sense; the uncommon, as selected by judgment; and the perfect, which, as before observed, subsists in imagination.

If we diligently attend to the progress of the arts in Greece, or after their revival in Italy, we shall observe three distinct periods: first, when they went no further than merely copying an object; secondly, when they selected their object; and lastly, which marks the highest point of excellence, when they produced works of pure imagination.

The beauty of the naked requires several qualities to its perfection; as, that the form be in proportion, and well shaped; that it possess a free and easy motion, and be of a sound and fresh colour. The two latter will be treated of in their proper places, while here we shall content ourselves with offering the proportions found in De Piles, as some guide in the search of truth: besides, as the painter deals in foreshortening, they are not altogether of that importance as to the statuary.

"The antients have commonly allowed eight heads to

their figures, though ſome of them have but ſeven; but we ordinarily divide the figure into ten faces*, that is to ſay, from the crown of the head to the ſole of the foot, in the following manner:

" From the crown of the head to the forehead is the third part of a face.

" The face begins at the root of the loweſt hairs which are upon the forehead, and ends at the bottom of the chin.

" The face is divided into three proportionable parts: the firſt contains the forehead, the ſecond the noſe, and the third the mouth and chin; from the chin to the pit betwixt the collar bones are two lengths of a noſe.

" From the pit betwixt the collar bones to the bottom of the breaſts, one face.

" From the bottom of the breaſts to the navel, one face†.

" From the navel to the genitals, one face‡.

" From the genitals to the upper part of the knee, two faces.

" The knee contains half a face.

" From the lower part of the knee to the ancle, two faces.

" From the ancle to the ſole of the foot, half a face.

" A man when his arms are ſtretched out is, from the longeſt finger of his right hand to the longeſt finger of his left, as broad as he is long.

" From one ſide of the breaſts to the other, two faces.

" The bone of the arm called *humerus* is the length of two faces, from the ſhoulder to the elbow.

" From the end of the elbow to the root of the little finger, the bone called *cubitus*, with part of the hand, contains two faces.

" From the box of the ſhoulder-blade to the pit betwixt the collar bones, one face.

" If you would be ſatisfied in the meaſures of the breadth from the extremity of one finger to the other, ſo that this breadth ſhould be equal to the length of the body, you muſt obſerve that the boxes of the elbows with the humerus, and of the humerus with the ſhoulder-blade, bear the proportion of half a face, when the arms are ſtretched out.

" The ſole of the foot is the ſixth part of the figure.

* This muſt depend on the age and quality of the perſons. The Apollo and Venus de Medicis have more than ten faces: the Hercules has ſeven heads, as ſuiting great bodily ſtrength.

† The Apollo has a noſe more.

‡ The Apollo has half a noſe more; and the upper half of the Venus de Medicis is to the lower part of the belly and not to the privy parts.—See Audran's Antient Statues.

" The

" The hand is the length of the face.

" The thumb contains a nose.

" The inside of the arm, from the place where the muscle disappears, which makes the breasts, (called the pectoral muscle,) to the middle of the arm, four noses.

" From the middle of the arm to the beginning of the head, five noses.

" The longest toe is a nose long.

" The two outmost parts of the teats, and the pit betwixt the collar bones of a woman, make an equilateral triangle.

" For the breadth of the limbs no precise measures can be given, because the measures themselves are changeable according to the quality of the persons and according to the movement of the muscles. DE PILES."

The measures of the antient statues by Audran will be found highly useful, as they are accompanied with outlines of those the most distinguished for correctness.

The proportions of children differ from the adult as follow: The child of two years old has about five heads in its whole length, three of which go to the upper part, and two to the lower: one of four or five years old, has near six heads; and at fifteen or sixteen, seven heads are the proportion.

In infants, the centre or middle part between the two extremities of the head and feet, is the navel; in the adult it is the *os pubis*.

It is the character of the man to be broadest on the shoulders; the woman on the hips. This will be found to hold good in the male and female in most of the animal race.

It has been premised that the proportion of the figure must vary according to the character, as what would suit an Hercules would by no means agree with Apollo.

By proportion, we wish to be understood a correspondence and agreement of the measures of the parts between themselves and with the whole.

Much ingenious argument has been used by the author of " The Sublime and Beautiful" to prove that proportion is not the cause, or rather one of the causes, of beauty. In his inquiry that author appears to have expected, the proportion of one animal being laid down, admitting it beautiful, that it ought to serve as a general standard for the whole of creation. " Examine the head of a beautiful horse; find what proportion it bears to his body and to his limbs, and what relation they have to each other; and when you have settled these proportions as a standard of beauty, then take a dog or cat, or any other animal, and examine how far the same proportions between its head and its neck, between

thoſe and the body, and ſo on, are found to hold." That they differ in every animal is beyond all queſtion, but that there is a general ſtandard of proportion for each is equally unqueſtionable; for, were there not ſome ſuch ſtandard, nature would in time produce ſuch a jumble of ſhapes, that it would be impoſſible to diſtinguiſh an ox from a greyhound; to the confuſion of all order and ſymmetry. Beſides, from the proportion laid down as rules of art, though an indifferent artiſt cannot inſure beauty, yet he will be almoſt certain of general character.

The author before mentioned goes on to obſerve, with a view to eſtabliſh his point: "It ſeems amazing to me that artiſts, if they are as well convinced, as they pretend to be, that proportion is a principal cauſe of beauty, have not by them at all times accurate meaſurements of all the beautiful animals, to help them to proper proportions when they would contrive any thing elegant, eſpecially as they frequently aſſert that it is from an obſervation of the beautiful in nature that they direct their practice." Thoſe meaſures the artiſt has by him as far as he can obtain them, the value of which is known to him from their great utility. Even the vulgar appear ſenſible of proportion; hence the nick name of *long ſhanks*, from thoſe parts wanting the cuſtomary proportion. The "ſmoothneſs" of the ſkin of a dropſical perſon will never be pleaſing, any more than that of a perſon over fat, from the want of proportion, the parts appearing too thick for the height.

That ſmoothneſs in painting is not one of the cauſes of beauty is apparent from the pictures of Vanderwerf, the exceſs of which gives the fleſh the appearance of ivory: beſides, the ſmoothneſs muſt depend on the ſize of the picture in a great degree. It is true, we ſometimes ſee a large picture highly finiſhed, and a ſmall one crude and ſlight; but ſuch a practice is contrary to common ſenſe: large ones require a boldneſs of handling, *not a ſlightneſs or indication of form only*; and ſmall ones greater delicacy. It muſt alſo be evident that the ſtyle of execution muſt be governed by the nature of the ſubject: if it be dignified, the handling ſhould be bold, as what would add a grace to a low ſubject would detract from a great one, as much as a common and vulgar idea would debaſe what is lofty.

It is not a ſingle ſenſible quality that can conſtitute an object beautiful, but a combination of them, as we ſhall find by a recapitulation of the foregoing remarks.

We wiſh to be underſtood as confining ourſelves to the beauty of the human figure, the qualities eſſential to which will

will be found to conſiſt in a juſt proportion; that the parts be well ſhaped; a free, affable, mild, and eaſy motion; a ſound and freſh colour, with the tints melting and tender; that the direction of its lines be gently varied, and by no means approaching to angular; and, laſtly, that it is accompanied in a picture with a certain degree of ſoftneſs and finiſhing.

The Greeks ſeem to have conſidered the exiſtence of beauty and paſſion as incompatible: hence ſo little expreſſion is found in the Niobes; they appear always to have ſacrificed the latter to the former.

XXXVI. *Experiments and Obſervations on certain Stony and Metalline Subſtances which at different Times are ſaid to have fallen on the Earth; alſo on various Kinds of Native Iron.* By EDWARD HOWARD, *Eſq. F. R. S.*

[Continued from p. 141.]

Examination of the Stone from Benares.

THIS ſtone, as the Count de Bournon has already remarked, has the moſt diſtinguiſhed characters. Indeed it is the only one of the four, ſufficiently perfect (if I may be allowed that expreſſion) to be ſubjected to any thing approaching to a regular analyſis.

The cruſt, or external black covering, is the firſt ſubſtance to which the attention is naturally directed. When a portion of this cruſt had been detached with a knife, or a file, and finely pulverized, I ſeparated the particles attractable by a magnet; and digeſted the unattractable portion with nitric acid, which was preſently decompoſed; but, owing to a ſtrong adherence of ſome of the interior and earthy parts of the ſtone, it did not diſentangle the coating or metalline part without ſome difficulty. The acid being ſufficiently neutralized, the ſolution was paſſed through a filter, and ſaturated to exceſs with ammonia. An abundant precipitate of oxide of iron was produced; and, when this oxide was ſeparated, I obſerved the ſaline liquor to have a greeniſh colour. I evaporated it to dryneſs; and rediſſolved the dry ſalt in diſtilled water. No precipitate was formed during the evaporation, nor was the colour of the ſolution entirely deſtroyed. It appeared to me like a triple ſalt, deſcribed by Mr. Hermſtadt* as an ammoniacal nitrate of nickel. By examination

* *Annales de Chimie*, tom. xxii. p. 108.

with

with pruſſiate of ammonia, it yielded a whitiſh precipitate, inclining to a violet colour; and, by various properties, I was ſoon confirmed in the opinion that nickel was preſent. Since I ſhall have occaſion more than once to treat of the triple compound, and ſince it has been only mentioned by Mr. Hermſtadt, it is neceſſary now to detail ſome of its diſtinctive characters. The ſame chemiſt informs us, that the three mineral acids, with ammonia, enter into ſimilar combinations with nickel; and I have obſerved that oxide of nickel can be diſſolved by nitrate and muriate of ammonia. The muriate ſeems to take up the largeſt quantity. The colour of this ſalt is by no means uniform: it is ſometimes graſs green, violet, roſe colour, inclining to purple, and I have ſeen it almoſt colourleſs. It ſeems to be purple, and to incline to roſe colour and violet, when all the oxide of nickel is not united to both acid and alkali, but, from the deficiency of ſalt, is held in ſolution by an exceſs of ammonia. In this caſe, evaporation, of courſe, precipitates the nickel in the ſtate of oxide, which is of a whitiſh green colour.

The nickel cannot be *precipitated* from a perfectly formed triple ſalt by any reagent I have tried, except by a pruſſiate, or a hydrogenized ſulphuret of ammonia. Potaſh and lime, as well as, I preſume, other bodies, ſtanding in the order of affinities before ammonia, decompoſe the ſalt; but the nickel is then continued in ſolution by the diſengaged ammonia.

As it may be imagined that I have occaſionally met with copper, when I deſcribe a violet or purple ammoniacal ſolution, it is right to obſerve, that to avoid this error, I have either reduced the liquor to a neutral ſtate, and endeavoured, without ſucceſs, to obtain from it a precipitate, with a ſolution of ſulphureted hydrogen gas; or, by adding an acid to ſlight exceſs, and immerſing a piece of iron, I have not been able to detect a trace of copper. Theſe, and many other trials, when they do not appear to be made before the eſtimation of the quantities of nickel, have been conſtantly made afterwards.

But, to return to the incruſtation or coating of the ſtone, the decompoſition of the nitric acid ſhowed the preſence of matter at leaſt nearly metallic, although not attractable; and the examinations made of the liquor, from which the iron was precipitated, aſcertained the preſence of nickel beyond diſpute. The difficulty of obtaining the coating of the ſtone, either diſtinct from matter not belonging to it, or in ſufficient quantity, induced me to relinquiſh the idea of attempting to give the proportions of its conſtituent parts.

The ſtone being deprived of its covering, the ſhining particles

ticles irregularly diſſeminated next demand examination. I firſt examined the pyrites. Their very looſe texture made it exceedingly difficult to collect the weight of 16 grains, which was however effected by the dexterity of the Count de Bournon.

I digeſted theſe, at a low heat, with weak muriatic acid; which acted gradually, and diſengaged a trifling but ſenſible quantity of ſulphureted hydrogen gas. After ſeveral hours, I found the acid diſcontinued its action. The whole metalline part appeared in ſolution; but ſulphur and earthy particles were obſervable. The ſulphur, from its ſmall ſpecific gravity, was ſuſpended through the ſolution; whilſt the earthy matter, which could not be ſeparated by mechanical means, was fortunately left at the bottom of the digeſting veſſel. I decanted off the ſolution, holding ſuſpended the ſulphur; and, by repeated waſhing, ſeparated every thing belonging to the pyrites from the inſoluble earthy matter, the ſubtraction of which reduced the weight of real pyrites to 14 grains. I next obtained the ſulphur, by filtration. When it was as dry as I could make it, without fear of its being ſublimed, its weight was two grains. To the filtrated liquor I added nitrate of barytes, by way of detecting any ſulphuric acid which might have been preſent; but no cloudineſs enſued. I then ſeparated, by ſulphate of ammonia, the barytes thus added, and precipitated the iron with ammonia. The liquor, on the ſubſidence of oxide of iron, appeared of a violet purple colour: it contained nickel, which I threw down with ſulphureted hydrogen gas, there being already a ſufficient exceſs of ammonia in the ſaline liquor to form an alkaline hydrogenized ſulphuret. The oxide of iron, after ignition, weighed 15 grains; and the ſulphuret of nickel, reduced to an oxide, weighed, after the ſame treatment, ſomething more than one grain. The proportions of the ſubſtances contained in the pyrites of the ſtone from Benares may therefore be conſidered nearly thus:

	Grains.
Sulphur - - - - - -	2
Iron - - - - - -	$10\frac{1}{2}$
Since 15 grains of the oxide repreſent about that quantity of iron,	
Nickel, nearly - - - - -	1
Extraneous earthy matter - - -	2
	$15\frac{1}{2}$.

It is obſervable that, notwithſtanding the loſs appears to be only half a grain, it was probably more, becauſe the ſulphur

phur could not be reduced to the ſame ſtate of dryneſs in which it exiſted when in combination with the iron; not to ſay that it was, in a ſmall degree, volatilized with the hydrogen gas diſengaged during the ſolution.

The weight of nickel is a mere eſtimation. We are not yet ſufficiently acquainted with that metal to ſpeak of it with accuracy, except as to its preſence. Upon the whole, however, it may be concluded, that theſe pyrites are of a very particular nature; for, although Henkel has obſerved that ſulphur may be ſeparated from pyrites by muriatic acid, it is by no means the uſual habitude of pyrites to be of ſuch eaſy decompoſition.

The other ſhining particles immediately ſeen, when the internal ſtructure of the ſtone is expoſed, are the malleable iron. Before I ſtate the examination of this iron, I muſt remark, that preliminary experiments having ſhown me it contained nickel, I treated ſeveral kinds of the moſt pure irons I could obtain, with nitric acid; and precipitated the oxide from the metallic ſalt by ammonia. The quantity of oxide I obtained from 100 grains of iron was from 144 to 146. I may conſequently infer, that 100 grains of pure iron acquire, by ſuch a proceſs, 45 grains of oxygen; and that, whenever a metallic ſubſtance, ſuppoſed to be iron, does not, under the ſame circumſtances, acquire the ſame proportionate weight, ſomething is either volatilized, or left in ſolution. Hence, when a metallic alloy of nickel and iron preſents itſelf, a judgment may, at leaſt, be formed of the quantity of nickel, by the deficiency of weight in the precipitated oxide of iron.

This mode of treatment was not allowed me in the examination of the coating of the ſtone, becauſe it was impoſſible to know in what ſtate of oxidizement the iron exiſted. But, as the particles diſſeminated through the whole maſs are clearly metallic, a very tolerable idea of the quantities of nickel contained in them will be obtained, by noting the quantity of oxide of iron ſeparated, as above deſcribed. 25 grains of theſe metallic particles were therefore heated with a quantity of nitric acid, much more than ſufficient to diſſolve the whole. Some earthy matter, which, as in a former caſe, was not ſeparable by mechanical means, remained after a complete ſolution of the metal had been effected. This earthy matter, after being ignited, weighed two grains. The real matter of the preſent examination was therefore reduced to 23 grains, and was in complete ſolution. I added ammonia to a very ſenſible exceſs. The oxide of iron was thereby precipitated, and, being collected

and

and ignited, it weighed 24 grains; whereas, according to my experiments, $33\frac{1}{2}$ grains ſhould have been produced from the ſolution, had it contained nothing but iron. I examined the ſaline liquor, when free from ferruginous particles, and diſcovered it to be the triple ſalt of nickel. Hence, allowing for loſs, the quantity of nickel may be eſtimated, by calculating the quantity of iron contained in 24 grains of oxide. Thus, if 145 grains of oxide contain 100 of iron, about $16\frac{1}{2}$ are contained in 24 of oxide. This would ſuppoſe the 23 grains of alloy to conſiſt of $16\frac{1}{2}$ iron and $6\frac{1}{2}$ nickel; which, if the uſual loſs be added to the $16\frac{1}{2}$ grains of iron, and deducted from the nickel, may not be very remote from the truth.

I ſhall next examine the globular bodies, alſo irregularly diſperſed throughout the ſtone. A number of them were reduced to fine powder; but nothing metallic could be ſeparated by the magnet. As a preliminary experiment, I ſought for pyrites, by digeſtion with muriatic acid; but no hepatic ſmell was in the leaſt perceivable, nor was white carbonate of lead at all altered by being held over the mixture. I therefore conclude theſe globular bodies do not envelope either iron or pyrites. By way of analyſis, I treated 100 grains with potaſh, in a ſilver crucible; and, after the uſual application of a red heat, ſeparated as much ſilica as poſſible, by muriatic acid and evaporation. The ſilica being collected on a filter, carbonate of potaſh was added to the filtrated liquor; by which a precipitate almoſt wholly ferruginous was produced. This precipitate was collected in the common way; then boiled with potaſh, to extract alumina; and, by ſuperſaturating the alkaline liquor with muriatic acid, and precipitating by carbonate of ammonia, an earth was gathered, which I afterwards found to be partly, if not entirely, ſiliceous. After rediſſolving, in muriatic acid, the portion of the ferruginous matter rejected by the potaſh, I precipitated by ammonia, what I took to be entirely oxide of iron; but, after igniting it, and again attempting to rediſſolve the whole in muriatic acid, more ſilica was left. The non-exiſtence of lime was proved, by the addition of carbonate of ammonia, immediately after the ſame alkali, pure, had thrown down what I took wholly for oxide of iron. I had now obtained every thing in the ſubject of my analyſis, except magneſia and nickel. The former, and a trace of the latter, were held by carbonic acid in the liquor, from which the ferruginous precipitate was, in the firſt inſtance, thrown down by carbonate of potaſh; and the latter was found in the laſt-named muriate of ammonia. I diſengaged the magneſia, by the aſ-

ſiſtance

ſiſtance of potaſh, and by evaporating to dryneſs. The oxide of nickel was precipitated by hydrogenized ſulphuret of ammonia.

Under all circumſtances, I am induced to ſtate the proportions of conſtituent parts thus:

Silica - - - - -	50
Magneſia - - - -	15
Oxide of iron - - - -	34
Oxide of nickel - - -	$2\frac{1}{2}$
	$101\frac{1}{2}$

The exceſs of weight, inſtead of the uſual loſs, is owing to the difference of oxidizement of the iron, in the ſtone and in the reſult of the analyſis; which will be found to be the caſe in all analyſes of theſe ſubſtances; indeed it is always neceſſary to reduce the oxide to the red ſtate, as being the only one to be depended upon. To avoid future repetition, I ſhall alſo obſerve, firſt, that by preliminary experiments I could not detect any other ſubſtance than thoſe mentioned. Secondly, that the earth obtained as alumina appeared to me to be moſtly, if not entirely, ſiliceous; becauſe, after it had been ignited, and again treated with potaſh and muriatic acid, I found it was very nearly all precipitated by evaporation. Thirdly, I examined, and judged of, the ſilica collected from the oxide of iron, in the ſame way. Fourthly, the weight of the magneſia is given, not immediately, as obtained by evaporation, but after a ſubſequent ſolution in an acid, and precipitation by potaſh. And, fifthly, the proportions are taken from the mean of two analyſes.

Nothing remains to be examined, of the ſtone from Benares, except the earthy matter, forming a cement or matrix for the ſubſtances already examined. 100 grains of this matter were, by mechanical means, ſeparated as perfectly as poſſible, from the pyrites, iron, and globular bodies, and analyſed as above. The mean reſult of two analyſes gave,

Silica - - - - -	48
Magneſia - - - -	18
Oxide of iron - - - -	34
Oxide of nickel - - -	$2\frac{1}{2}$
	$102\frac{1}{2}$

XXXVII. *Me-*

XXXVII. *Memoir on the Anatomy of Vegetables. Read before the Phyſical Claſs of the Inſtitute by* C. MIRBEL.

[Concluded from p. 179.]

CHAP. VII.

Of the Pores.

THE pores are ſmall apertures formed in the membranes; they favour evaporation, abſorption, and the motion of the fluids. There are three kinds of them.

1ſt, *The inſenſible pores.*—Theſe are apertures which cannot be perceived by the eye even when aſſiſted by the moſt powerful microſcopes. Effects, however, do not permit us to doubt of their exiſtence. Every vegetable tiſſue is full of them, as is proved by inſenſible tranſpiration. What ſhows at the ſame time their extreme fineneſs is the phænomenon exhibited by an apple, or any other pulpy fruit, when placed below the receiver of an air-pump: the highly dilated air eſcapes only by burſting the ſkin.

2d, *The elongated pores.*—Theſe have been obſerved by ſeveral naturaliſts, and particularly Decandolle, who gave them the name of cortical pores. I ſhall endeavour to complete his deſcription, by uniting under the ſame point of view his obſervations and thoſe which I have ſince made myſelf. For a knowledge of the principal facts I am indebted to his reſearches; but, as he conſidered this ſubject rather in a phyſical than an anatomical light, his labour does not ſuperſede the neceſſity of publiſhing mine.

The elongated pores exiſt only in the epidermis of the herbaceous parts expoſed to the air and the light. If the exterior membrane of the vegetable be ſkilfully removed, and if you then examine it with a microſcope, you will ſee the interior ſides of the epidermis ſtill adhering, and which form as it were a hexagonal net-work; but here and there inſtead of a hexagon you will obſerve an ellipſe, and the part of the epidermis circumſcribed by that elliptical area is cleft in a longitudinal direction: the aperture is ſometimes free, and ſometimes obſtructed: the latter caſe, in my opinion, ariſes from the lips of the pore, longer than is neceſſary to ſhut the aperture, being applied one to the other, and intercepting the light. The elongated pores are found commonly in the ſtems, the branches, the leaves, the bracteæ, and even the herbaceous pericarpia. In herbaceous plants the two ſurfaces of the leaves are covered with pores; in the fat plants they are leſs numerous than in the other vegetables. In trees and ſhrubs the inferior ſurface only is in general pierced with theſe pores. The ſtems when

they become ligneous are deſtitute of them. Theſe pores ſerve for the ſenſible and inſenſible tranſpiration and for the abſorption of the fluids. They each correſpond to a ſmall cell, which, according as the air is moiſter than the cellular tiſſue, or the cellular tiſſue than the air, abſorbs the fluids diſperſed throughout the atmoſphere, or throws off thoſe which the vegetable contains. When the parts become ſtiff, and the liquors contained in the vegetable have no longer the ſame fluidity, theſe cells become filled with thick gum and reſin; which not being able to eſcape through the pores, nor to return into general circulation, become entirely hard; and are at length thrown out, when the ſtate of the vegetable, by not permitting the epidermis to dilate itſelf further, forces it to burſt.

3d, *The glandular pores.*—Theſe are apertures bordered with thick opake and unequal rolls. Theſe pores ſerve for the movement and communication of the fluids in the interior of the vegetable. They are obſerved ſometimes indeed in the epidermis, but this caſe is exceedingly rare. There are two kinds of glandular pores, the ſmall and the large. The former are exceſſively ſmall. To the moſt powerful microſcopes they appear only like the ſmall holes made in a ſheet of paper with the point of a needle: ſometimes they are ſcattered, and few in number; at other times they are very numerous, and diſpoſed in regular ſeries, always according to the breadth, and never according to the length of the tiſſue. The large glandular pores are only a modification of them: one might even ſuppoſe that the union of the ſmall pores of one ſeries produces the large ones, the direction of which is the ſame as that of the ſeries. The reader muſt here call to mind what I have already ſaid of the porous tubes, the falſe tracheæ, and even the tracheæ. There are ſome very ſtriking relations between theſe different tubes, and the plan of nature is not equivocal.

Chap. VIII.

Of the Epidermis.

This name is given to the exterior membrane formed by ſides of the outer cells; or rather the epidermis is only the term of the cellular tiſſue itſelf.

To relate every thing that authors have ſaid on this membrane, would fill a volume. No part in the organization of plants has given riſe to more reſearches, nor perhaps has led into more errors. The firſt fault is, to have compared it without reſtriction to the epidermis of animals. When this idea was once adopted, every thing elſe was conſidered as analogous. The epidermis, ſaid ſome writers, exiſts in all organized

ganifed beings; it covers the nafcent embryo, and the individual which has arrived at the ftate of decrepitude; it follows all the finuofities of bodies, penetrates into their cavities, and protects the moft delicate parts: thus in animals, after enveloping all the external parts, comprehending even the globe of the eye, it is feen falling back on the lips, penetrating into the inteftinal canal, into the noftrils, and the auditory paffage; and in plants, it covers the ftems, branches, leaves, flowers and fruits. The epidermis (add they) is not fimilar in every part of the fame being: fometimes it is exceedingly fine, and fometimes it affumes more conliftence; but in all cafes it is colourlefs and tranfparent. If it appears white on the trunk of the birch-tree, and brown on the young branches, afh-gray on the plum-tree, red and argenteous on the cherry-tree, green on the young fhoots of the almond-tree, and afh-coloured on the old ones; this difference depends merely on the colour of the fubftances it covers, in the fame manner as the white, black, and copper colour of the white, negro or caffre depend on the colour of the mucous body. By following this comparifon, a new point of fimilitude is thought to be obferved in the dilatability of the epidermis of animals and plants: it yields to all development, and extends in proportion as the being grows: it embraces only a fmall furface in the fœtus of the animal, but it dilates infenfibly and covers a much greater furface when the animal attains to its utmoft growth. It is thus that the epidermis which covers the feeds of plants dilates and yields to the increafe of the fruit, and that the epidermis which covers the embryo yields alfo to the increafe of trees. The extenfion of this membrane will be found to be prodigious, when we conlider what the gourd was before its flower withered, and what the oak was when concealed in the acorn. But, as there are certain animals the old epidermis of which detaches itfelf, and at the end of a certain time gives place to another; in the fame manner there are certain vegetables which throw off their epidermis in order to affume a new one. It is obferved that the epidermis of the trunk and branches of the plane-tree detaches itfelf in ferolls like that of oviparous quadrupeds.

Thefe comparifons, no doubt ingenious, are far from being exact in every point. It may even be faid that they are founded on imperfect obfervations. To be convinced of this, it will be fufficient to reflect on the definition we have given of the epidermis of vegetables. This membrane is nothing but the exterior union of the cells of the circumference, and differs from the membranes which form the other fides only by the changes occafioned by its pofition. If it is lefs tranf-

parent, drier and firmer, it is becauſe it is continually expoſed to the influence of the light and the air, and to the contact of all thoſe bodies which float in the atmoſphere: but it is not in reality a diſtinct part; and it may be ſaid, ſtrictly ſpeaking, that vegetables have no organ analogous to the epidermis of animals. When vegetables grow large, the exterior membrane ſeems to dilate; but if this membrane becomes extended, it is becauſe the number of the cells is multiplied at the circumference as at the exterior, and that conſequently the ſides which compoſe it are multiplied in proportion, and increaſe its capacity.

One objection remains to be combated. It may here be ſaid, Why is it ſo eaſy in the ſpring time to detach the epidermis from the young branches, if it does not really form a diſtinct organ? This may be explained in the following manner:—All cauſes which have an external action on the vegetable alter its ſurface, and detach from it the interior parts: but this ſeparation becomes more apparent when the vegetation is more vigorous, and when the fluids moiſten the cellular tiſſue, and fill the tubes; for, as the diſorganized ſurface cannot then develop itſelf with the reſt, it ceaſes to adhere, and often comes off in fragments, or is inſenſibly deſtroyed. This is exactly what takes place in the ſpring.

In a word, this exterior ſtratum, which ſo many circumſtances tend to deſtroy, and which almoſt always exhibits traces of its diſorganization, is not compoſed of the laſt membrane only: the interior part of the cellular tiſſue is found in it, as is evident in the plane tree, and ſtill more in the green oak, which produces cork. What has been here ſaid is applicable only to the ſtems and branches, which do not die in the courſe of the year; for in herbs, and the annual parts of ligneous plants, ſuch as the leaves, flowers, bracteæ, &c. the ſurface does not detach itſelf from the reſt of the tiſſue.

But the epidermis of vegetables has no reſemblance to that of animals; and, though it is certainly formed by the exterior part of the cellular tiſſue, it is no leſs true that its nature is modified by ſecondary cauſes, and that it in fact becomes an organ, the functions of which are very diſtinct, and highly important. In the infancy of the vegetable, when all the parts are ſoft and mucilaginous, it oppoſes at the ſame time the diſunion of the naſcent organs, and the too ſtrong action of the fluids. At a more advanced age, when the juices are leſs abundant, it prevents their too ſpeedy evaporation, and maintains a juſt equilibrium between the ſolids and the fluids. At all times it ſecures the vegetable

from the deleterious influence of meteors, and ſhelters it from exceſſive heat, cold, moiſture, and drought. In a word, it protects it againſt all external cauſes which might hurt it. Beſides this, it ſerves for ſenſible and inſenſible tranſpiration, and the abſorption of gas, and of thoſe fluids diſperſed throughout the atmoſphere. For this reaſon it is often pierced with very viſible pores: I ſay often, becauſe it is not indeed a general law; and the epidermis of pulpy fruits, for example, has no apparent pores. I muſt add, alſo, that theſe fruits tranſpire very little, as Dr. Hales has ſhown in his Vegetable Statics.

Chapter IX.

On the Organizing Subſtance, or Cambium of Duhamel. Hypotheſis on the Formation and Development of the Cellular Tiſſue and the Tubular Tiſſue.

All the parts of the vegetable have, at firſt, been mucilaginous and fluid; and it is only in the ſucceſſion of time that the tiſſue becomes firm and ſolid. This ſtate of feebleneſs is viſible in the ſeed. The embryo at firſt is but a drop of mucilage, in which the moſt powerful microſcopes diſcover no organ. This ſubſtance has a vitreous appearance. It is ſpeedily dried and deſtroyed by the contact of the air. Properly ſpeaking, it is not a fluid; it is an organized ſubſtance, ſimilar to the white of an egg. The organizing ſubſtance is formed during the whole time of the increaſe, and it depoſits itſelf in that part of the tiſſue where the vegetable ought to acquire the greateſt vigour. In the monocotyledons it is placed around each ligneous filament; in dicotyledons it is at the ſurface of the ſoft part of the wood and the medullary canal. Every day, therefore, the ligneous filaments of the cotyledons are ſeen to aſſume more volume, and the concentric ſtrata of the dicotyledons to be multiplied, and their pith to be converted into wood. The organizing ſubſtance is the more abundant, and is renewed with more facility as the individual is younger and ſounder; as it is in a more favourable ſituation, and as the ſeaſon is better fitted for vegetation. This ſubſtance inſenſibly aſſumes determinate forms, whether the fluids develop in it, by their impulſe, the cells and the tubes, or whether an unknown power acts in it alone, and determines theſe developments; or whether, as is probable, theſe two cauſes, united and combined, act in concert to change into membranous tiſſue the organizing ſubſtance, it is certain that the vegetable acquires a more conſiderable volume, and that it daily lengthens, and becomes

thicker. To explain the two phænomena of lengthening and becoming thicker, the action of which is ſimultaneous, we muſt acknowledge that the expanſive force acting in the membranous tiſſue newly created is modified by the nature of the tiſſue itſelf. It is compoſed, as we have already ſeen, of two organic elements, one of which is cellular tiſſue, formed of the cells, whoſe diameter is nearly equal in every direction; the other is the tubular tiſſue, formed of the ſmall and large tubes contiguous to each other. Let us ſuppoſe, for a moment, that the fluids imbibed by the vegetable are the cauſe of this diſſimilarity in the tiſſue. We may do ſo the more, as this ſyſtem is not void of probability. By way of example, let us employ the embryo: let us take the ſeed before fecundation: it is attached to the mother plant by the umbilical cord, the organization of which no doubt varies according to the ſpecies. By the help of the veſſels which unite this organ to the ſeed, the fluids penetrate into the organizing ſubſtance; and their impulſe being determined by the canals which afford them a paſſage, they then trace out the route which the fluids will afterwards purſue, and determine the order of the future developments. Being vigorouſly puſhed in different points, which vary according to the ſpecies, they open the longitudinal tubes, and then filter ſlowly through their ſides, depoſit themſelves in the organizing ſubſtance, and favour the development of the cells. In the firſt caſe, the fluids are puſhed by the force which gives motion to the ſap; in the ſecond caſe, they iſſue forth and penetrate the organizing ſubſtance only, becauſe they tend to aſſume an equilibrium. Theſe two forces, balanced by each other, produce a multitude of intermediate ſhades between the longitudinal tubes and the perfect cellular tiſſue. But this theory is ſtill far from explaining the phænomena of vegetable organization. There doubtleſs exiſt a thouſand other phyſical cauſes, the influence of which cannot be calculated; and above all theſe cauſes ought to be placed the organizing power, the principle of which is totally unknown to us.

However, the cells and tubes being once formed, they increaſe till the inſpiſſation and induration of the membranes preſent an obſtacle to their development. During the growth of the membranous tiſſue, the fluids carried into the tubes, by ſeveral forces combined, determine the direction of the elongation by the impulſe which they give to the organic moleculæ. But the cells ſuffer themſelves to be penetrated by the fluids only in a ſlow manner; and, being ſubjected to no force which determines their development in one direction rather than in another, they grow and dilate themſelves

ſelves in every direction. It would thence follow, if the cells grew equal in number to the tubes, that the cells ought to ſerve more for extending the thickneſs than the length of the vegetable, and that the inverſe would be the caſe with the tubes; but when the latter are greatly multiplied, their number compenſates for the ſmall thickneſs which each has, and they then contribute no leſs than the cells to the ſenſible thickening of the vegetable. Nay more, the maſs of the tubes is continually increaſed in trees, while the cells are not multiplied in the ſame proportion. In a word, ſeveral other cauſes, which I ſhall explain hereafter, contribute to diſorganize them, and even to transform them into tubes, ſo that at the end of a certain time the maſs of the latter is far ſuperior to that of the cells.

XXXVIII. *Experiments on Electricity excited by Evaporation. By a Correſpondent.*

SIR, *To Mr. Tilloch.*

I TAKE the liberty of communicating to you the following experiments on obtaining electricity by evaporation: and if you think them worthy of a place in your Philoſophical Magazine, by inſerting them therein you will very much oblige

June 9th, 1802. Your humble ſervant,

W. W.

THE apparatus I uſed for this purpoſe conſiſted of a gold leaf electrometer (hung in a phial, which had had the bottom cut off, that a conducting communication might be made between two ſlips of tinfoil, which were ſtuck on the inſide of the phial, and the earth,) and a tin diſh made in the form of the fruſtum of a cone. The top diameter of it is about 2 inches; the bottom diameter is about $1\frac{1}{2}$ inch, and its depth is about $\frac{1}{2}$ inch. This diſh, about half full of water, is placed on the electrometer, and the red-hot ſubſtances dropped into it from a pair of tongs, at 3 or 4 inches above it. (See Fig. 2. Pl. V.) In relating the experiments I ſhall put P. and N. to denote the two ſtates, commonly denominated *poſitive* and *negative*.

1. Cinder of pit-coal about the ſize of a walnut, dropped into the water, made the electrometer diverge N. This was repeated five times with the ſame reſult. Sometimes the gold leaf would beat againſt the ſide of the bottle four or five

times. I next made the electrometer diverge P. with an excited glaſs-tube, and while it was divergent dropped a hot cinder into the water: it immediately cloſed, and opened again N. The electrometer was then made N. with excited wax, and a cinder dropped into the water made the electrometer open wider, and ſtrike the ſide of the bottle.

2. I made fourteen ſimilar trials with coals of burnt wood, but could not find that any electricity was produced.

3. In ſixteen trials with tobacco-pipe the electrometer diverged N. eleven times, and five times it did not diverge at all. In five out of the eleven, after the electrometer had diverged, it cloſed again without touching the ſides of the bottle; but not ſo much as to loſe all its divergence.

4. In twenty-four trials with common white marble, the electrometer diverged P. twelve times, and ten times the gold leaf beat the ſides of the bottle ſo violently, that I could not determine which ſtate was produced; (but, becauſe it was P. in all thoſe when it could be determined, I ſuppoſe it was ſo in thoſe that could not) and twice it did not diverge at all: the pieces in theſe two were very ſmall.

5. In twelve trials with mother of pearl, (ſuh as common pearl buttons are made of) the electrometer diverged P. ſeven times. Three times I could not determine for the violent beating of the gold-leaf againſt the ſides of the bottle; and twice, when the pieces were very ſmall and not very hot, the electrometer became ſlightly N. It is probable there were ſome ſmall fragments of cinder thrown into the water with the pearl; for it was heated in a common fire, and taken out with a ſmall pair of tongs.

6. In eight trials with common white coral, the electrometer diverged P. every time.

7. In ſix trials with oyſter-ſhells, the electrometer diverged P. five times, and once it did not diverge at all: the piece was not hot enough to raiſe much vapour.

8. I made thirty-one trials with periwinkle-ſhells; and in the firſt ſeventeen trials the electrometer diverged P. ſix times, five times N., and three times it did not diverge at all; and twice it diverged and cloſed again directly, before I could determine which ſtate was produced. In the other fourteen trials it diverged P. every time. It is to be obſerved, that the ſhells uſed in the firſt ſeventeen trials were as they were when the fiſh was boiled and ſalted in them; they were therefore foul with ſalt, &c., and alſo had their outſide ſkins on: but in the fourteen laſt trials the ſhells were ſuch as had been burnt, and thrown into water while red-hot, before they were made hot for the experiment, and by

this

this treatment they were cleanſed from their ſkins and other foulneſſes.

9. In ſix trials with unprepared muſcle-ſhells, the electrometer diverged P. three times, once N.; once the gold leaf beat the ſides of the bottle ſo violently, that I could not determine; and once it did not diverge at all. As theſe ſhells were in the ſame ſtate as the periwinkle-ſhells were in the firſt ſeventeen trials with them, I therefore ſuppoſe the diſagreement to ariſe from the ſame cauſe.

10. In nine trials with chalk, I could not find that there was any electricity produced.

11. In twelve trials with bones, I could not find that there was any electricity produced.

12. In eight trials with gravel-ſtones, the electrometer diverged N. ſix times, and twice the gold-leaf beat the ſides of the bottle ſo violently, that I could not determine which ſtate was produced.

13. In five trials with clinkers, the electrometer diverged N. very gradually every time.

14. In eight trials with ſmall pieces of iron, the electrometer diverged N. ſix times, and twice not at all.

15. In ſix trials with ſome ruſty nails (that had lain in the earth till they were quite ruſted through, and from which I carefully waſhed the dirt, &c.), the electrometer diverged N. four times, and twice it did not diverge at all. Seeing this ruſty iron did not produce P., agreeably to Cavallo's experiment, I ſuſpected that, notwithſtanding all my care, the nails were not free from foulneſs. I next procured ſome flakes of ruſt which had fallen from an old anchor, which lies in Perry's dock-yard at Blackwall; and ſuppoſing theſe flakes to be pure ruſt, I expected to find the electrometer diverge P., but in ſeven trials it was N. every time.

16. In eleven trials with pieces of ſteel-file, the electrometer diverged N. eight times, once P.; once it did not diverge at all, and once it diverged and cloſed again before I could determine which ſtate was produced.

17. In two trials with pieces of china, the electrometer diverged N. both times.

18. In five trials with ſlate, the electrometer beat the ſides of the bottle violently, with N. every time.

19. A piece of fullers-earth made the electrometer diverge N.

20. In eight trials with a copper halfpenny, the electrometer diverged N. four times, and four times it did not diverge at all. And in eight trials with a penny piece, it diverged N. every time.

21. To diſcover in what ſtate (with reſpect to electricity) the vapour was, I uſed the apparatus repreſented by the annexed ſketch, of which the upright A B is of glaſs covered with ſealing-wax, and all the reſt, except the bottle of the electrometer, is of metal. In thirteen trials with cinders of pit-coal, the electrometer diverged P. ſeven times; four times it opened and cloſed again before I could determine which ſtate was produced, and twice it did not diverge at all.

22. In ſeven trials with marble, the electrometer diverged N. three times; three times it loſt all its divergence before I could determine in which ſtate it diverged, and once it did not diverge at all.

In the two laſt experiments, the electrometer retained its divergence ſo ſhort a time, that I was obliged to hold an excited tube in one hand, while I dropped the hot ſubſtance into the water with the other, to be ready in time to determine the ſtate produced by the vapour.

XXXIX. *Experiments and Obſervations on the Manufacture of Malleable Iron directly from the Ore. By* D. MUSHET, *Eſq. of the Calder Iron Works* *.

IN a former communication I took occaſion to remark that a variety of proceſſes had been followed out, endeavouring to form a good quality of bar iron with coak-pigs and pit-coal; but as theſe had been attended with little or no alteration of principle, the reſults had been nearly ſimilar. In no caſe has an uniform quality of bar iron been produced, able to cope for all uſes with the ſuperior marks of Sweden and Ruſſia.

At this day, aſſiſted by a variety of facts chemical and philoſophical, we yet remain in comparative ignorance of what conſtitutes the real difference in point of quality betwixt home-made iron and that imported from foreign markets. We acknowledge with pain and humiliation our dependence on other countries for our ſteel-iron, and it is with regret that we ſee every induſtrious exertion made to obviate this dependence foiled by the nature of our fuel, or the defective qualities of our ores.

Thoſe who have voluntarily made an offer of their time and abilities for the ſervice of their country, in promoting a thorough knowledge of the principles of our manufactures, could not engage in a ſubject fraught with more important

* Communicated by the Author.

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conſequences. An acurate chemical analyſis of the various ſtates and qualities of Britiſh manufactured iron, accompanied by a ſimilar development of the component parts of the foreign fabrics, would prove an intereſting contraſt, and could not fail ultimately of producing infinite advantage to that department of labour.

I ſhall not, at preſent, enter into an inveſtigation of the probable reaſons which conſtitute this difference, but confine myſelf to a ſuccinct account of ſeveral proceſſes in which I have obtained malleable iron, often ſuperior to the common run of Britiſh manufacture. In contemplating theſe manipulations followed out in the large way, I uniformly found that, although ſome fabrics poſſeſſed comparative excellence, yet that all were deficient in obtaining a quality of iron equal in appearance and fracture to the foreign.

In all theſe proceſſes it was evident that if the contact of pit-coal, conſidered as a more impure fuel than wood, was hurtful to the quality of the iron, then all our bar-iron would be ſo injured, as all of it is manufactured either in contact with ſuch fuel, or the flame of it, or both. The point therefore wiſhed to be gained was the making of bar-iron without bringing the metal, while in fuſion, in contact either with the flame of pit-coal, or with the ignited coaks. My firſt crude attempt was in 1794 with crucibles and roaſted ironſtone. I conceived that by introducing juſt as much charcoal of wood as would remove the oxygen of the ore, that malleable iron would be the reſult. Experiment, in ſome meaſure, juſtified this conjecture: but a want of uniformity in the reſult proved the fallacy of this mode of operating. When the temperature was moderately raiſed, I found the iron partially ſeparated, and, in a malleable ſtate, entangled amongſt the earths of the ore: but, when a higher degree of heat was brought on, the greateſt part of the iron was found precipitated in the form of a button. The iron in this ſtate was malleable: but ſo exceſſively red-ſhort as to be incapable of drawing at any ſhade of heat beyond faint red.

In varying theſe experiments, and uſing a greater proportion of charcoal than uſual, I was ſurpriſed to find, that after a long and violent heat no part of the iron had entered into fuſion. The pieces of iron-ſtone were firmly connected together, poſſeſſed of the original acuteneſs of angle and fracture. Their appearance and ſurface was dark and metallic, and, upon attempting to part them, I found them attached to each other by a ſpecies of metallic fibre, which twiſted repeatedly before breaking. This was a ſpecies of welding I had never before witneſſed. I found the whole maſs ſufficiently

ciently metallic upon the ſurface to receive a conſiderable degree of poliſh from a file. The interior of each piece, from the want of a ſufficient doſe of heat, remained in a ſoft, eaſily pulveriſed form, perfectly magnetic, and burning with great rapidity when ſtrewed in the flame.

The apparent advantages which ſeemed to reſult from this chance diſcovery were ſufficient to induce me to perform, during the courſe of three or four years, ſeveral hundred experiments. In the proſecution of this ſubject, I ſoon abandoned the uſe of iron-ſtones. It was found requiſite to uſe them in a roaſted ſtate; and even afterwards, when heated in contact with charcoal for three or four days, it was with the greateſt difficulty that the proceſs of malleability could be made to penetrate to the centre without a general and premature fuſion, which was always carefully to be avoided. When raw iron-ſtone was uſed, it was difficult to prevent it from entering into fuſion, and ſeparating its iron in the ſtate of minute globules of crude iron. Having thus ſatisfied myſelf of the precarious reſults obtained in this proceſs by the uſe of iron-ſtones, I had recourſe to Cumberland ore, as a fit ſubſtitute, and my expectations in it were not diſappointed.

I ſhall ſimply ſtate the methods which I ultimately followed to produce bar-iron in this proceſs with the uſe of pit-coal and charcoal of wood. Having prepared a ſmall furnace with an oblong cavity, ſurrounded with a ſufficient number of holes to admit the heat all round, I introduced 50 to 60 lbs. of Cumberland iron ore reduced to pieces of nearly 3 ounces weight each. This was mixed with a ſufficient quantity of clean duſt produced in the charring of coal. The ore was ſurrounded by a layer nearly $2\frac{1}{2}$ inches thick, and this laſt of all was covered with a layer of moiſt ſand 2 to 3 inches thick. The fire was maintained at a temperature of nearly 100° of Wedgewood for 36 to 48 hours, according to circumſtances. It was then allowed to cool gradually. Upon examination, the pieces of ore were frequently found attached to each other ſo firmly as to require conſiderable force to part them. They filed, and were, when the cementation was continued long enough, malleable throughout. The ore, thus prepared, was piled up in a flat broad ſhallow crucible with a looſe top, and placed in a furnace heated with the flame of pit-coal. A welding heat was brought on the whole maſs, which was then carried to the hammer: the firſt blow deſtroyed the crucible, and the ore was ſhingled into a bloom at the firſt heat.

In this way excellent iron was produced. Its fracture was light

light blue, fibrous, and tearing conſiderably in groups. It poſſeſſed, however, a ſlight degree of red-ſhortneſs when very highly heated. It formed with equal facility horſe-ſhoes and nails of the moſt delicate ſtructure. The produce of the raw ore never exceeded 47 per cent., and commonly was from 43 to 45. Iron of a more pure fracture was obtained by piling the ore upon a flat cake of fire-clay or ſand-ſtone. As the welding heat penetrated the maſs, part of the earth and unmetallized particles of iron were reduced into fuſion, and run off into the furnace. The produce, however, in iron was reduced as low as 37 per cent. This reduction of metal, no doubt, aroſe from the greater ſurface expoſed in this way than when the balling pot was uſed.

To obviate this, and, at the ſame time, inſure an equal quality of iron, the piles were heated in the ſame furnace with the gas of coaks, and the flue of the furnace nearly ſhut up; ſo that the circulation of air was much ſmaller, and the heat, though equally great, yet more attenuated. This produced a better quality of iron than any of the former ways, but at a greater expenſe of fuel.

However ſuitable this iron was for the common uſes of the ſmithy, it was found to form but a very indifferent quality of ſteel by cementation. The whole of it became in ſome degree laminated, and incapable of ſtanding great fatigue; and the red-ſhortneſs, which before faintly marked the bar iron, was now conſiderably increaſed when in the ſtate of ſteel.

In varying this proceſs of making bar iron, quantities of the prepared ore were thrown upon the top of a ſmall finery fire, charged with ſoft coal coak, and ſunk to the bottom. The metallic maſs was found connected, and ſo much purified as to afford iron of a clear fracture, but the produce was diminiſhed to 28 and 30 per cent. from raw ore.

The ſame ore, however, ſunk in a ſmall fire of wood charcoal, yielded a very ſuperior quality of the metal to any of the former. In point of quality and fracture, it was deemed no way inferior to many of the beſt Swediſh marks. Still, however, it muſt not be denied, that this iron formed comparatively but an inferior quality of ſteel. In this ſtate I left this proceſs for making bar iron, and have not yet found time nor ſufficient opportunity to reſume it. Of late years I underſtand a proceſs, ſomewhat ſimilar, has been eſtabliſhed near Whitehaven, in the neighbourhood of the Cumberland iron-mines, but abandoned, not becauſe the quality of iron was inferior, but I believe from a want of œconomy in the proceſs itſelf.

A thouſand unforeſeen difficulties occur in ſtriking out a new

new line of manufacture, before a good quality of product is obtained. Theſe are ſeldom diminiſhed, but often increaſed, in transferring it from the ſcale of experiment to that of manufacture.

In the preſent proceſs followed out at the bar-iron forges in this country, the greateſt drawback upon the profits and correctneſs of the buſineſs is the immenſe loſs of metal. This is called waſte, and it is generally believed that the more the waſte the better the quality of the reſulting iron. This circumſtance I conceive is owing to the following facts—the combuſtibility of the metal, the high temperature requiſite, and the tedious length of the proceſs. The puddling proceſs invented by Cortes avowed a degree of ſimplicity, which promiſed to leſſen the waſte by diminiſhing the variety of operations, and the length of the expoſure. Experience however has proved, that, in general, what was gained in weight was more than loſt by the inferior quality of the iron produced.

With a view to produce a quality of iron from coak pig equal or ſuperior to what is obtained in the beſt proceſſes now in uſe, it occurred to me that an operation which would unite the properties of the finery fire and of the puddling furnace would be productive of a good quality of iron, and with little comparative loſs. With this view a ſmall furnace was contrived, ſomewhat ſimilar in ſhape to an iron-founder's air furnace. The depth of the grates below what is called the bridge of the furnace was more in proportion. A ſhallow cavity was formed in the middle of the furnace with ſand, about two inches deep, fifteen inches long, and eight broad. The furnace was heated to a bright white heat with raw pit-coal: a ſmall door was then opened, and nearly 84 lbs. of fragments of white crude iron introduced. The grates of the furnace were then charged with coaks, and a ſemifuſing heat brought on, and continued for ten hours after. During this operation the metal continued to boil, and diſcharge a blue vapour, frequently accompanied with hiſſing exploſions. At laſt, when the metal exhibited no further ſigns of ebullition, nor of fuſion, the fire was allowed to die away. When cold, I found the whole, without ſtirring or agitation, reſolved into a maſs of malleable iron, which, even in this ſtate, was broken with great difficulty. The lump, or plate, was divided into three pieces, one of which was drawn into a ſtout bar, and weighed 18 lbs. The quality of this iron was excellent for every purpoſe, ſteel-making excepted. In this proceſs it diſjoined, and formed laminæ; which rendered it unfit for any ſteel purpoſe. This experiment was frequently

quently repeated with ſimilar reſults: but, from ſeveral circumſtances not here neceſſary to be mentioned, I never aſcertained the exact loſs ſuſtained in the operations. I am confident, however, that it would not amount to more than half what is experienced in the common proceſſes.

I offer this ſlight ſketch, as I did the former, merely as an outline of an operation, the perfection of which might be attended with great advantages, but which would previouſly require a conſiderable portion of time, and many experiments, to eſtabliſh.

XL. *An Eſſay on Longevity.* By Sir JOHN SINCLAIR, Bart.

[Continued from p. 172.]

APPENDIX.

No. I.

THE preceding obſervations are only intended as a baſis, for the purpoſe of obtaining the additional facts and obſervations which are neceſſary to elucidate ſo important an inquiry. It is particularly requeſted, therefore, that the following queſtions may be anſwered with as much minuteneſs and accuracy as circumſtances will admit of.

Queſtions for the conſideration of thoſe intelligent perſons by whom this Paper may be peruſed:—

1. What is the effect of the climate in which you reſide, on the health and longevity of the human race?

2. What form is reckoned moſt conducive to health and longevity?

3. Is it found, that being deſcended from young and from healthy parents, is eſſential for good health and old age?

4. Is it found, that health and old age depend much on the diſpoſition or temper of the individual?

5. Is there any perceptible difference in conſequence of ſituation of life?

6. What profeſſions are reckoned favourable to longevity, or otherwiſe?

7. Is exerciſe or moderate labour found neceſſary for preſerving health and long life?

8. Have the long-lived in general been in the marriage-ſtate?

9. Have the greateſt proportion of the long-lived conſiſted of males or females?

10. Have there been any inſtances of perſons renewing their age, getting new teeth, new hair, &c.?

11. What are the other circumſtances tending to promote long life?

12. What is the effect of diet on health and longevity?

13. What are the effects of clothing?

14. What the effect of habitation, and the difference of living in a town or in the country?

15. What are the effects of habits and cuſtoms, in regard to early riſing, bathing, regular meals,—regular ſleep,—and, in particular, what are thoſe minute circumſtances on which it is ſuppoſed that health and longevity principally depend?

16. What are the rules regarding medicine which are accounted the moſt uſeful and ſalutary?

17. What are the moſt remarkable inſtances of longevity, and how are they authenticated?

18. What are the rules adopted by thoſe who have attained great age?

19. Have any tables of longevity been drawn up in your neighbourhood, and how do they agree with the one extracted from Hufeland?

20. Do any additional obſervations or particulars occur to you on the ſubject of health or longevity?

No. II.

Of ſuch Rules and Habits as may contribute to the Preſervation of good Health and long Life.

If perſons were to live with the ſimplicity of ancient times, it is probable that they would attain long life, without experiencing any material illneſs, merely by a proper attention to air, exerciſe, clothing, and diet. But in the preſent ſtate of ſociety, the great bulk of the community muſt follow, not a natural, but an artificial mode of life, and thence are perpetually expoſed to various temptations, which they find it difficult always to reſiſt, and to dangers which they cannot always avoid. In luxurious times, therefore, perſons in general cannot expect to live long, at leaſt with any degree of ſatisfaction, unleſs by great care, and by an attention to a variety of minute particulars, which they either learn from others, or acquire by their own experience. The maſs of uſeful facts and obſervations thus accumulating every day, and periſhing daily with thoſe who had acquired them, muſt be very great. Unfortunately, hitherto, no individual has taken the trouble of collecting them. Such a collection would certainly be a moſt acceptable offering to the public, more

more eſpecially if written in a plain and diſtinct manner, and laying down ſuch rules alone as were practicable according to the general ſtyle of modern life. With the view of contributing to ſo uſeful a work, I ſhall proceed to ſtate ſuch obſervations as have been either communicated to me by others *, or have occurred to myſelf on that intereſting ſubject.

The

* Among other communications I received from a friend in the country, a number of rules of diet and regimen, written in Latin as far back as the year 1648, in anſwer to the general queſtion; "By what means a "perſon might be enabled to prolong life to the lateſt period?" The following is a literal tranſlation of that Paper:

A perſon will be enabled to prolong life to the lateſt period, by obſerving the following ſalutary rules.

1. The ſtomach ought never to be over-loaded with food, otherwiſe the body will be rendered unfit for exertion.
2. Moderation in exerciſe, food, drink, ſleep, and venery.
3. No freſh food ſhould be taken, unleſs the preceding meal has been properly digeſted.
4. The meals ſhould not be uniform; but ſupper always lighter than dinner.
5. Exceſs in former meals muſt be corrected by a ſubſequent abſtinence.
6. All food ſhould be duly maſticated before it be ſwallowed.
7. The quantity of drink ſhould always be proportioned to that of ſolid food.
8. No drink ſhould be taken until a due portion of ſolid food has been ſwallowed.
9. A variety of diſhes ought not to be eaten at the ſame time.
10. It will be adviſable to refrain from a meal (dinner) once a week, particularly when the body appears to require leſs food.
11. Bodily exerciſe ſhould be ſo managed once a day, as to excite the natural heat (glow); and before a meal. The advantages reſulting from ſuch practice are thus deſcribed by FULGENTIUS: "Exerciſe," ſays he, "contributes to the preſervation of human "life; it diſſipates all ſuperfluous humours of a plethoric habit; "it invigorates our faculties; it is a gain of time; the enemy of "idleneſs, the duty of the young, and the delight of the aged. "For exerciſe diſengages and expels, through the pores, all ſu"perfluous humours; while the greateſt injuries may enſue from "a contrary conduct: hence the Poet obſerves, 'Eaſe is not to "be acquired unleſs it be combined with toil: for indolence is "generally attended with diſſolution.'"
12. In taking food, liquids and ſoft ſubſtances ought to precede thoſe of a dry and ſolid nature.
13. Between meals, both ſolid and liquid food ſhould be avoided.
14. The bowels ſhould be regular every day, either by nature or by artificial means.
15. Extremes of heat and cold, with reſpect to food, drink, and air, are equally to be guarded againſt.
16. Sleep ought not to continue leſs than ſix hours, nor exceed eight.
17. Immediately after a meal, and with a full ſtomach, it is hurtful to engage in reading, writing, or deep reflections.
18. Violent

The particulars connected with food, clothing, habitation, air, and exerciſe, are ſo univerſally known, and the principles regarding each ſo fully eſtabliſhed, that it is ſurely unneceſſary to dwell upon them at any length.

In regard to food, experience will point out thoſe articles which are beſt adapted for the conſtitution of each individual; and there cannot be a better general rule than to adhere to them as cloſely as poſſible. It may be obſerved, however, that people in general, eſpecially thoſe who do not labour, eat much more than nature requires; that a little abſtinence or ſelf-denial may often be of uſe, either to prevent or to cure diſeaſe *; and at any rate, that none but hard-working people, or thoſe who are in the very prime of life, or growing faſt, or travelling about, ſhould eat more than one full meal each day.

18. Violent exerciſe, ſhortly after a meal, ought never to be undertaken.
19. When the body is in a languid ſtate, all the limbs ſhould be vigorouſly ſtretched.
20. Drink ſhould never be taken on an empty ſtomach; as, in that ſtate, it cannot fail to prove exceedingly hurtful by agitating the nerves. Galen ſays, in the ſecond Aphoriſm, 21, If a hungry perſon drink wine before he eat, he will ſpeedily be attacked with ſpaſms and delirious ſymptoms. Nor ſhould wine be taken (habitually) after meals; becauſe it unnaturally accelerates the digeſtion, propels the food before it is properly digeſted, and lays the foundation of obſtructions and putridity.
21. Wine ſhould never be taken immoderately; and it would be adviſable, as much as poſſible, to abſtain from its uſe, becauſe it affects the brain: hence, no perſon of a weak organization ſhould venture to drink it, unleſs in ſmall quantities, or diluted. Serapio remarks, "Wine fills the head with many va-
"pours."
22. The bread ſhould be of the beſt quality, ſoft, (not too ſtale,) and mixed with a ſmall portion of ſalt.
23. Cheeſe, and all the artificial preparations of milk, ought to be avoided; though pure milk, when mixed with ſugar, may not be deemed unwholeſome during the ſummer. Milk and water, or whey, is a ſalutary beverage at all ſeaſons.
24. Fiſh ſhould be ſeldom eaten, and then they ought to be tender and well dreſſed, with the addition of vinegar, ſpices, and other ſauces.
25. Oyſters, and all ſhell-fiſh, ſhould be avoided, becauſe they afford only a cold, ſlow, and viſcous nouriſhment."

There are many uſeful hints in theſe Rules, though ſome of them are not applicable to general uſe, according to the modern ſtyle of living.

* After a diſeaſe is removed, if there is much laſſitude and weakneſs, nothing will be found more uſeful than to take a cruſt of bread and a glaſs of very old and rich ſweet wine at noon. This plan was ſtrongly recommended to me by ſome intelligent perſons on the Continent, who had reaped much benefit from it.

As

As to clothing, much muſt depend on ſituation and climate *; but, on the whole, it is generally found a uſeful practice to wear woollens next the ſkin. It is remarked in many parts of Scotland, that ſince the uſe of flannel ſhirts has been given up by the lower orders, the rheumatiſm, and other diſeaſes formerly unknown, have become very frequent, and are daily increaſing. In the Weſt India Iſlands, if care be taken to make the troops wear flannel ſhirts, they are likely to be exempted from various diſorders, which otherwiſe would probably have attacked them. Even the negroes themſelves, I underſtand, prefer flannel to cotton or linen, and find it a much more comfortable and uſeful dreſs. In regard to clothing ſuited to the climate of Great Britain, there is reaſon to believe that we uſe furs much ſeldomer than we ought to do. Nothing can be more abſurd than to conſider the uſe of fur as a mark of effeminacy, and on that account to ſuppoſe that it is merely calculated for delicate women. In the piercing cold to which we are often ſubjected, furs might be worn with much advantage by the ſtouteſt and hardieſt men.

The nature of the houſe where any individual reſides, is a very important conſideration. Formerly they were very ill fitted up, and were what would now be conſidered extremely uncomfortable. It was ſaid of old, that no houſe was wholeſome "where a dog could not get in under the door, or a bird through the window." There was then no uſe for ventilators. The caſe is now much altered. The art of finiſhing houſes cloſely, and the management of fuel, have been brought to ſuch perfection, as greatly to exclude a free circulation of air, and to overheat that which the room contains. From the great expenſe of building and fitting up houſes, alſo, the apartments in them are in general much ſmaller and leſs lofty than they ought to be. As it is impoſſible to make any great alteration in theſe particulars, more eſpecially in the metropolis, and in large towns, which contain ſo large a proportion of the population of the kingdom, the only remedies are, to ventilate the houſes whenever the weather will admit of it; and for the inhabitants of towns to be as much in the open air, and as frequently in the country, as circumſtances will permit †.

* See an Eſſay, Philoſophical and Medical, by Dr. Vaughan, concerning Modern Clothing. Printed *an.* 1792.

† It has been remarked, that perſons reſiding in Scotland in ſummer, and in England in winter, generally enjoy excellent health; and it is believed that nothing would tend more to promote the health of the citizens of London, than an annual excurſion to the mountains of Wales, or the highlands of Scotland.

In regard to exerciſe, it cannot be too much recommended; and as, from various circumſtances, perſons in large towns, and engaged in various ſedentary occupations, cannot take all that exerciſe abroad that may be neceſſary for their health, they ought as much as poſſible to accuſtom themſelves to be walking about even in their own houſe, inſtead of ſitting ſo much as is uſually the caſe. This rule is peculiarly neceſſary to be attended to by literary men; and though ſuch a practice does not make up for the want of exerciſe abroad, yet it certainly is the beſt ſubſtitute for it.

But the principal object of any extenſive paper on this ſubject ſhould be, to point out thoſe habits, or minute particulars, which contribute to good health and old age. We frequently ſee perſons living luxurioufly, and keeping even irregular hours, without being much troubled with diſeaſe. It is not improbable, were the truth known, that this is owing to trifling attentions, the reſult of obſervation and experience, which prove of infinite ſervice to them, and which might be of equal advantage to others, were they collected by ſome public-ſpirited individual, and univerſally diſſeminated.

I believe there is no habit that contributes more to good health and good ſpirits, or renders a man fitter for going through a great deal of buſineſs, than that of taking a ſufficient quantity of ſleep, from ſix to eight, and even nine hours, if nature requires it. I underſtand that the late lord Mansfield frequently inculcated the advantages to be derived from a rigid adherence to ſuch a ſyſtem; and it is well known the quantity of buſineſs he went through, and the good health and good ſpirits he enjoyed for a great number of years. To continue long in bed without ſleeping, is weakening and injurious; but a perſon may take all the repoſe that nature requires, and will have time ſufficient, during the remainder of the day, to go through all the neceſſary buſineſs, and to enjoy all the real pleaſures of life.

It is generally ſuppoſed, that early riſing is alſo eſſential to good health *. Without being an advocate for what are called faſhionable hours, which are carried to ſo prepoſterous an exceſs, converting night into day, and day into night, ſome doubts may be expreſſed regarding the propriety of carrying the oppoſite ſyſtem to too great a height. In antient times, when people depended almoſt entirely on the ſun for light, they were under the neceſſity of riſing with that luminary, and of going to bed when it diſappeared. Hence a prejudice aroſe

* The old maxim was,
Early go to bed, and early riſe,
Makes a man healthy, wealthy, wiſe.

in

in favour of that practice; but the caſe is greatly altered ſince the means of obtaining artificial light to ſo great an extent have been diſcovered. I queſtion much, whether the morning air is ſo wholeſome as many imagine. The ſun muſt neceſſarily extract from the earth, when it firſt appears, a variety of vapours, which ſtrong conſtitutions may withſtand, but which muſt be injurious to weak ones: even in large towns, it is ſome time before the morning fogs are diſſipated. On the whole, late riſing cannot be approved of, but very early riſing is not probably ſo eſſential for health as is commonly imagined.

There is nothing that can tend more to long life than for a perſon to obtain a complete command of his paſſions, and in particular to preſerve his mind from being ruffled. Perhaps there is no maxim more likely to promote good health, than that of paying a proper attention to *temper*, *temperance*, and *ſleep*. By good temper, the mind is preſerved from diſeaſe; and by temperance, the body; and both the mind and the body, when exhauſted, are again recruited and reſtored to their former ſtrength by a ſufficient quantity of repoſe.

In ſo variable a climate as that of the Britiſh Iſles, it is of the utmoſt importance to contrive the moſt effectual means of preventing various diſorders ariſing from checked perſpiration, as colds, coughs, conſumptions, ſore throats, rheumatiſms, &c. by which ſo many thouſands are cut off every year. The following hints are the reſult of ſome attention to that particular ſubject.

1. It is generally acknowledged that the uſe of flannel next the ſkin is a great preſervative againſt catching cold, and all the diſorders connected therewith. This is a point ſo well eſtabliſhed that it is unneceſſary to dwell upon it*.

2. There is not a better mode of being able to withſtand the variableneſs of our climate, than to adopt the Spaniſh practice of wearing an under waiſtcoat made of thin ſhamoy leather, which tends to preſerve the body in an equal temperature. This is particularly uſeful when perſons are in a weak ſtate after indiſpoſition, or are likely to be affected with rheumatic complaints.

3. Many perſons are apt to be frequently attacked by complaints in the throat, which may, in general, be prevented by attention to the following circumſtances. It is uſual for perſons to make uſe of hot water for ſhaving, the conſequence of

* The principal objection to wearing flannel is its tendency to excite too great perſpiration in bed; but this is eaſily obviated by wearing a flannel waiſtcoat with buttons at the ſhoulders, ſo that it can be taken off at any time without inconvenience.

which is, that the glands of the throat are much relaxed, and very apt to be affected by cold. It has been found by experience, an excellent cuſtom to uſe cold inſtead of hot water, though the latter may be employed in warming the razor, which adds to the comforts of ſhaving. Perſons apt to have ſore throats, if they ſuſpect they have caught cold, ſhould, as ſoon as poſſible, gargle their throats with ſpirits, which may alſo be applied with much advantage to the outſide of the throat.

4. Perſons who hunt or ride much, are greatly expoſed to get wet, and catch diſorders in conſequence thereof, of which multitudes of all ages have periſhed. The remedy, however, is a very ſimple one. Whenever ſuch a circumſtance happens, particularly to any perſon not accuſtomed to get wet, he ſhould as quickly as poſſible rub his feet with a towel dipt in rum or any other ſort of ſpirits, the effect of which in reſtoring the animal heat of the whole body is almoſt inſtantaneous. This practice, I underſtand, has been found of the greateſt ſervice abroad, and the great Frederick of Pruſſia recommended it ſtrongly to his ſoldiers to adopt it; though, in general, they were much more inclined to drink their brandy than to make this uſe of it.

The next particulars which it may be proper to advert to, are the ſkin, the teeth, and the eyes.

It is well known that the health of the individual depends much upon the ſtate of the ſkin, and that good health can never be enjoyed unleſs when it performs its functions properly. For that purpoſe, it is neceſſary that it ſhould be kept in a clean ſtate. The attention paid to this ſubject by antient lawgivers, and founders of religious ſyſtems, cannot be too much recommended. They actually made the keeping the body clean, by frequent waſhing, part of the ſacred duty of each individual. The uſe of linen, and the cuſtom of throwing off the dreſs of the day, when going to ſleep, (which is not the caſe with Aſiatic, but fortunately is now ſo general with European nations,) renders bathing much leſs eſſential, but ſtill the practice is too much neglected in this country; and in large towns, furniſhing the people with the means of bathing commodiouſly ought to be a part of the general police *.

It is impoſſible too ſtrongly to recommend an early and conſtant attention to the teeth. In former times, when perſons lived with great ſimplicity, the teeth ſeldom failed until the body was on the verge of diſſolution; but now, it is hardly

* The ſhower baths, and waſhing the body with wet ſponges, have been found of great uſe in various complaints, and a great preſervative againſt catching cold.

to

to be credited, how few pay ſuch attention to their teeth as will preſerve them in any tolerable order for a long period. This is the more ſurpriſing, as a good ſet of teeth is ſo ornamental, ſo eſſential for diſtinct pronunciation, and ſo neceſſary for a proper maſtication of the food. In a paper of this deſcription, it is only poſſible to touch upon this important ſubject. It may be proper, however, to obſerve a common miſtake, that tooth-bruſhes, as they are called, are intended for rubbing the teeth, whereas their proper buſineſs is to rub the gums, and to excite a circulation there. It is diſeaſes in the gums that principally occaſion the deſtruction of the teeth, and preſerving the one in good order materially contributes to the ſafety of the other *.

The little attention that is ſhown to the preſervation of the eyes, is fully as blameable as the negligence above alluded to in regard to the teeth. Any imperfection in the ſight is ſuch a calamity, that every perſon of common prudence would certainly wiſh to prevent it by every poſſible means; and there is certainly no mode more likely to be effectual, than that of bathing them night and morning in a baſon of cold water, and opening the eyes in the water. Any diſorder that attacks the eye itſelf, from the pain and uneaſineſs which it occaſions, muſt be attended to. But the eye-lids become often diſeaſed and ulcerated; and though there are various ointments which would cure this diſorder at the commencement, yet, as it is not very bad or troubleſome, people are too apt to put it off from time to time, until the eye itſelf is affected, and a cure becomes hardly practicable.

It is imagined by ſome, that taking of ſnuff is a uſeful practice in preventing diſorders in the head, and in the eyes in particular; and in the liſt ſubjoined of the In-penſioners in Greenwich Hoſpital who have exceeded the age of 80 years, a very large proportion uſe tobacco in ſome ſhape or other. The taking of ſnuff is certainly refreſhing, and loaded as it is with a heavy tax, it ſtill is a cheap luxury for the poor; and the evidence from Greenwich Hoſpital ſufficiently proves, that the uſe of ſnuff and tobacco, though not to be univerſally recommended, yet is not incompatible with long life.

In a book publiſhed on the ſubject of longevity †, ſome circumſtances are occaſionally mentioned regarding the food and habits of perſons who lived to a great age. Among theſe, the following ſeem to be the beſt entitled to notice; "1. John

* Some people have their teeth ſo regular and well ſet, that little attention is neceſſary; but wherever there is any irregularity, nothing but the greateſt care, and the ſkill of an able dentiſt, can preſerve them long.

† By Mr. James Eaſton, of Saliſbury, printed in 8vo. *an.* 1799.

Huſſey, of Sydenham, in Kent, who lived to be 116. For above 50 years his breakfaſt was balm tea ſweetened with honey, and pudding for dinner, by the uſe of which he acquired long and regular health. 2. Judith Banniſter, aged 108. She lived upon biſcuit and apples, with milk and water, the laſt 60 years of her life. 3. John Riva, of Venice, aged 116, always chewed citron-bark. 4. Elizabeth Macpherſon, of the county of Caithneſs, aged 116. Her diet was buttermilk and greens. 5. Francis Conſit, of Burythorpe, near Malton, Yorkſhire, aged 150, occaſionally ate a raw new-laid egg. 6 Fluellyn Price, of Glamorgan, aged 108. Herb teas were his breakfaſt, meat plainly dreſſed his dinner, and inſtead of a ſupper he refreſhed himſelf with a pipe of tobacco. 7. Val. Cateby, of Preſton, near Hull, aged 116. His diet for the laſt twenty years was milk and biſcuit. 8. Edward Drinker, of Philadelphia, aged 103. He lived on very ſolid food, drank tea in the afternoon, but ate no ſupper. 9. Lewis Morgan, of Radnorſhire, aged 101. He lived chiefly on vegetable diet, and drank frequently of the famous rock water of Llandrindod. 10. Mr. Smith, of Montgomeryſhire, aged 103. He was never known to drink any thing but buttermilk. 11. William Riddle, of Selkirk, in Scotland, aged 116. For the laſt two years of his life, his chief ſubſiſtence was a little bread infuſed in ſpirits and ale. 12. Honourable Mrs. Watkins, of Glamorganſhire, aged 110. For the laſt 30 years ſhe ſubſiſted entiely on potatoes. 13. Rebecca Joſeph, of Monmouthſhire, aged 100. Her chief ſubſiſtence, for the laſt two years of her life, was brown ſugar and cold water. 14. Charles Macklin, Eſq. of London, aged 107. For the laſt 40 years of his life, his principal beverage was white wine and water, made pretty ſweet; and after he had loſt his teeth, his food principally conſiſted of fiſh, eggs, puddings, and ſpoon-meat. Having been attacked by a ſevere fit of the rheumatiſm, he diſcontinued the uſe of ſheets, and ſlept in blankets. He uſed to be frequently rubbed all over with warm brandy or gin, (which ſeems to be a good practice for aged people,) and occaſionally ſteeped his feet in warm water. It was his cuſtom not to ſleep on a feather bed, but on a mattreſs, on a couch without curtains, placed in the centre of the room, upon which he repoſed whenever he found himſelf ſleepy. Inſtead of attending to regularity, he obſerved the dictates of nature, ate when hungry, drank when thirſty, and ſlept when nature ſeemed to require repoſe.

Among practices which might be of ſervice to aged people, I ſhould imagine that rubbing the body with oil would be particularly uſeful. It might tend to preſerve the ſkin in a

ſoft

ſoft and healthy ſtate, and to furniſh the body with that unctuous matter, which very old people ſeldom have to the extent that is neceſſary; and hence thoſe wrinkles which are ſo peculiar a characteriſtic of old age.

I am alſo perſuaded, that in regard to various diſorders, particularly thoſe with which the aged are apt to be afflicted, a great ſource of benefit ſtill remains to be explored, in the practice of electricity, by the uſe of which, not through the medium of violent ſhocks, but by gradually diffuſing that important fluid throughout the whole frame, the body is reanimated with freſh vigour, and rendered fitter to go through its various functions with renewed ſpirit and ſtrength.

There is certainly nothing that would tend more to preſerve health and longevity, than improvements in the medical art, which, though it has made conſiderable progreſs in ſome particular departments, yet continues deficient in many others. When it is conſidered the number of able men who are employed in the medical profeſſion, the importance of the objects to which their attention is directed, and the multitude of caſes which are daily and even hourly coming under their review, one would think that hardly a circumſtance could poſſibly happen that might not be foreſeen and guarded againſt. Perhaps one mode of improving the art would be, requiring all phyſicians to communicate to the College an account of any caſe that ſeemed to throw light upon the mode of curing any particular diſeaſe. Honorary premiums might be given to thoſe who make any uſeful diſcovery; and it is to be hoped that the munificence of Parliament to Dr. Jenner will ſhow what may be expected by medical men who make any improvement of real and eſſential importance.

I ſhall conclude with obſerving, that man has been compared, and with ſome truth, to a machine; but he ought not to be conſidered as a machine that wears out by mere uſe, without the poſſibility of being repaired; but like one whoſe movements may be improved, whoſe wheels, after being diſordered, may be again put into their former, and perhaps even an improved ſtate, and whoſe frame may be long preſerved by care, by attention, and by the ingenuity and exertions of ſkilful artiſts.

No. III.

On the Longevity of the Penſioners in Greenwich Hoſpital.

Being convinced that much light would be thrown on the ſubjects of health and longevity, were accurate returns made from hoſpitals and other public inſtitutions, of the diet, age,

and other particulars regarding the perſons who reſided in them, I was thence led to apply to Greenwich and Chelſea Hoſpitals for ſuch information; and it is with much pleaſure that I ſubjoin the following important facts with regard to Greenwich Hoſpital, which Dr. Robertſon, at the deſire of the reſpectable Maſter of that moſt excellent inſtitution, (lord viſcount Hood,) tranſmitted to me.

I ſhall inſert the Tables as prepared by Dr. Robertſon, and ſhall offer ſuch obſervations as may occur on the reſults to be drawn from each of them reſpectively.

Obſervations on the annexed Table.

Doctor Jameſon, of Bloomſbury-place, has made the following remarks on the Table:

"Dr. Robertſon certainly deſerves much praiſe for his attention in tranſmitting ſo particular a ſtatement of the longevity of Greenwich Hoſpital; and if ſomething ſimilar could be procured from other public inſtitutions in Great Britain and Ireland, it would not be difficult to form an arrangement of facts, that would afford important concluſions concerning the lives of mankind.

"The Table communicated by Dr. Robertſon favours an opinion, that the watery element is not unfriendly to the human frame, eſpecially when it is aided in advanced life by the comforts of Greenwich Hoſpital.

"The liſt of ninety-ſix men in that Hoſpital ſtill alive, in extreme old age, is uncommonly great; and it appears from the table, that there is one man living above a hundred years old, and 13 above 90 years of age.

"That the greateſt number are natives of Scotland, and a large proportion from Ireland.

"That one half belonged to aged families, many of whom had both parents very old.

"That more than two-thirds had been upwards of 20 years in the king's ſervice, and in various climates;

"That they were almoſt all married, and four of them after 80 years of age.

"That they almoſt all uſed tobacco, and moſt of them acknowledged the habit of drinking freely.

"That the parts of the human body which had moſt generally failed, were the teeth. Some of them had no teeth for 20 years, and 14 only had good teeth.

"That the organ of viſion was impaired in about one half, and the organ of hearing in about a fifth part of them."

As Dr. Robertſon propoſes publiſhing a new edition of his intereſting work on the Diſeaſes incident to Seamen, it was

Age.	Names of Penſioners upwards of 80 Years of Age.	Where ſuch Perſons were born, and educated.	If their Families were long lived.	How long in King's Service.	Whether they lived in cold or warm Climates.	If ever married.	If in the habit of drinking freely.	If in the habit of uſing Tobacco freely.	The ſtate of their Organs, and Mental Faculties.	The ſtate of their Teeth.
80	Thomas Kindred.	Born at Dublin, in Ireland, and educated.	Grandfather 94.	32 years.	Moſtly cold.	52 years.	Freely.	Chews freely.	Very dim-ſighted. Very infirm.	Bad Teeth.
80	William Lee.	Born in St. James's London, and educated.	Not remarkable.	20 years.	Moſtly warm.	20 years.	Freely.	Chews freely.	Not ſenſible.	Bad Teeth.
81	William Gammon.	Born in London, and educated.	Not remarkable.	30 years.	Moſtly warm.	35 years.	Freely.	Chews freely.	Eye-ſight good.	Bad Teeth.
82	Thomas Griſley.	Born at Bithopgate, London, and educated.	Not remarkable.	21 years.	Moſtly cold.	50 years.	Freely.	Chews freely.	Eye-ſight good.	Good Teeth.
82	John Mager.	Born at Wells, in Somerſetſhire, and educated.	Grandfather 92.	36 years.	Moſtly cold.	Never married.	Moderate.	Not any.	Eye-ſight very good. Very infirm.	Bad Teeth.
82	John Biggs.	Born at St. Martin, London, and educated.	Grandfa. 90. Father 78.	34 years.	Moſtly warm.	9 months married	Moderate.	Chews moderate.	Very good.	Bad Teeth.
84	John Wellers.	Born in London, and educated.	Grandfa. 97. Une. 90.	30 years.	Moſtly warm.	33 years.	Freely.	Chews freely.	Rather dim-ſighted. Very infirm.	Bad Teeth.
84	William Smith.	Born at Stepney, and educated.	Not remarkable.	3 years.	Moderate.	32 years.	Freely.	Chews freely.	Very good.	Middling Teeth.
85	Robert Padgett.	Born at Hammerſmith, Middleſex, and educated.	Not remarkable.	7 years.	Moderate.	40 years.	Freely.	Snuffs freely.	Very good.	Very bad Teeth.
85	Thomas Fowler.	Born at Walthamſtow, in Eſſex, and educated.	Not remarkable.	21 years.	Moſtly cold.	Never married.	Moderate.	Not any.	Very dim-ſighted. Otherwiſe good.	Good Teeth.
86	Will. Rowelington.	Born at Alderſgate, London, and educated.	Not remarkable.	56 years.	Moſtly warm.	20 years.	Freely.	Chews freely.	Very good.	Not a Tooth left.
94	John Garvis.	Born at Kidderminſter, in Worceſterſhire, and educated.	Uncle. 98.	20 years.	Moderate.	40 years.	Moderate.	Snuffs freely.	Very dim-ſighted. Very infirm.	Middling Teeth.
82	John Beaves.	Born at Colton, in Devonſhire, and educated.	Grandfather 90.	26 years.	Moſtly warm.	35 years.	Freely.	Not any.	Very hard of hearing.	
90	Owen Murrey.	Born at Tyrone, in Ireland, and educated.	Grandfather 130. Father - 100.	40 years.	Moſtly warm.	16 years.	Freely.	Chews freely.	Very dim-ſighted. Otherwiſe very good.	Bad Teeth.
86	Henry Hill.	Born at Bromley, in Surry, and educated.	Father 90.	25 years.	Moſtly warm.	Upwards of 30 years	Freely.	Not any.	Very good.	Middling Teeth.
83	James Hillhouſe.	Born at Air, in Scotland, and educated.	Mother 85.	20 years.	Moſtly warm.	About 17 years.	Moderate.	Very freely.	Rather dim-ſighted.	Not one left.
84	Robert Griffiths.	Born at St. George's in the Eaſt, and educated.	Not remarkable.	30 years.	Moſtly warm.	Never.	Mode ate.	Chews freely.	Very dim-ſighted and deaf.	Bad Teeth.
80	Francis Hopkins.	Born at Glouceſter, in America, and educated.	Not remarkable.	8 years.	Moſtly warm.	Never.	Moderate.	Chews freely.	Very good.	Bad Teeth.
80	Iſaac Smith.	Born at Whitehaven, in Cumberland, and educated.	Not remarkable.	20 years.	Moſtly warm.	45 years.	Moderate.	Never uſed any.	Dim-ſighted. Otherwiſe very good.	Very bad Teeth.
82	John Harford.	Born at Stokedamerel, in Devonſhire, and educated.	Grandmother 102.	28 years.	Moderate.	3 years.	Moderate.	Chews freely.	Good	Very bad Teeth.
80	Thomas Griffiths.	Born at Swanſea, in Wales, and educated.	Father 88.	17 years.	Moderate.	Never.	Freely.	Moderate.	Very good.	No Teeth theſe 20 years.
83	Nath. M'Nichols.	Born at Kilponar, in the Highlands, and educated.	Not remarkable.	32 years.	Moſtly warm.	6 years.	Moderate.	Not any.	Paſſied upwards of 20 years.	Bad Tee h.
80	William Jeffrey.	Born at Stepney, and educated.	Not remarkable.	15 years.	Moſtly warm.	52 years.	Moderate.	Chews freely.	Very good.	Bad Teeth.
81	John Web.	Born at Exeter, and educated.	Grandfather 80.	48 years.	Moſtly warm.	30 years.	Moderate.	Chews freely.	Very deaf. Otherwiſe good.	Bad Teeth.
81	William Durdon.	Born in Devonſhire and educated.	Mother 85.	23 years.	Moderate.	12 years.	Moderate.	Not any.	Rather dim-ſighted, rather deaf.	Middling Teeth.
81	Charles Mathews.	Born in Fifeſhire, in Scotland; and educated.	Grandfather 100.	50 years.	Moderate.	52 years.	Moderate.	Not any.	Dim-ſighted.	Middling Teeth.
80	John Plant.	Born at Harrow, educated at Greenwich School.	His Uncle 86.	20 years.	Moderate.	36 years.	Moderate.	Not any.	Very deaf.	Bad Teeth.
82	Stephen Haffer.	Born at Greenwich, educated at Greenwich School.	Not remarkable.	24 years.	Moſtly warm.	49 years.	Very moderate.	Not any.	Rather dim-ſighted. Otherwiſe very good.	Very bad Teeth.
81	James Godler.	Born at Stepney, and educated.	Not remarkable.	21 years.	Moſtly cold.	22 years.	Moderate.	Not any.	Dim-ſighted. Otherwiſe very good.	Bad Teeth.
90	Thomas Hacken.	Born at the Iſle of Wight, and educated.	Grandf. & mo ea. upwards of 100.	30 years.	Moſtly cold.	11 years.	Moderate.	Chews moderate.	Dim-ſighted, and deaf.	Middling Teeth.
83	Tub Hunter.	Born in Dublin, and educated.	Father 100. Aunt 104	11 years.	Moſtly warm.	50 years.	Freely.	Chews & ſnuffs, very freely.	Sight-ſtrong. Apppetite good.	Very bad Teeth.
80	Henry Richards.	Born at Philadelphia, and educated	Does not know.	32 years.	Moſtly warm.	Never married.	Very freely.	Chews freely.	Rather deaf.	Bad Teeth.
80	James Dempſy.	Born in Stafford, but educated in Waterford, Ireland.	Not remarkable.	22 years.	Moſtly warm.	40 years.	Moderate.	Not any.	Rather dimſighted.	Very bad Teeth.
80	Alexander Cooper.	Born at Swanſea, in Wales, and educated.	Grandfather 107.	32 years.	Moſtly warm.	Never married.	Moderate.	Not any.	Very good.	Not a Tooth left.
80	Emmanuel Carytefs.	Born at Chatham, and educated.	Mother 84.	12 years.	Moſtly cold.	36 years.	Moderate.	Not any.	Very good.	Bad Teeth.
80	William Anderſon.	Born at Gatton Heights Swedland, and educated.	Father 101. Mo. 100.	22 years.	Moderate.	7 years.	Moderate.	Chews freely.	Blind. Otherwiſe very good.	Middling Teeth.
80	George Weneman.	Born at Dublin, educated at York.	Grandmother 103. Grandfather 108.	25 years.	Moſtly warm.	30 years.	Very freely.	Chews freely.	Very good.	Very bad Teeth.
83	David Smith.	Born at Fernel Angus, N. B. and educated.	Grandfather 103.	14 years.	Moderate.	20 years.	Freely.	Not any.	Very good.	Bad Teeth.
85	Robert Martin.	Born at Buckland, in Somerſetſhire, and educated.	Not remarkable.	30 years.	Moſtly warm.	30 years.	Moderate.	Not any.	Very good.	Very bad Teeth.
82	Edward Smith.	Born at Galway, in Ireland, and educated.	Grand-Uncle 109.	12 years.	Moderate.	60 years.	Moderate.	Chews very freely.	Very good.	Bad Teeth.
80	John Keith.	Born at Air, in Scotland, and educated.	Not remarkable.	11 years.	Moderate.	59 years.	Moderate.	Chews moderate.	Sight dim. Otherwiſe good.	Bad Teeth.
84	Henry Pike.	Born at St. Paul's Church-yard, and educated.	Aunt 101. Uncle 99	24 years.	Moſtly warm.	40 years.	Moderate.	Very moderate.	Very good.	Bad Teeth.
87	John Haddon.	Born in South America, and educated.	Grandfather 105.	48 years.	Moſt'y warm.	Never married.	Moderate.	Chews freely.	Very good.	Bad Teeth.
85	Joſeph Bulger.	Born in Ireland, and educated.	Father 90.	20 years.	Moderate.	40 years.	Moderate.	Chews freely.	Pretty good.	Pad Teeth.
80	James Riley.	Born in the ſouth of Ireland, and educated.	Not remarkable.	30 years.	Moſtly warm.	Never married.	Freely.	Chews freely.	Sight dim. Otherwiſe good.	Pretty good.
		Born at Blandford in Dorſetſhire, and educated.	Grandfather 98.	11 years.	Moderate.	50 years.	Freely	Chews freely.	Sight dim. Otherwiſe pretty good.	Not one left.
							Freely	Chews freely.	Sight dim. Good appetite.	Not one left.

Age.	Names of Pensioners upwards of 80 Years of Age.	Where such Persons were born and educated.	If the Parents were long lived.	How long in King's Service.	Whether they lived in a cold or warm Climates.	If ever married.	If strict Habit of drinking fresh.	If in the Habit of using Tobacco freely.	The State of their Organs, and Mental Faculties.	The State of their Teeth.
86	George Forbes.	Born and educated at Aberdeen, North Britain.	Not remarkable.	18 years.	Warm.	20 years.	Freely.	Snuffs freely.	Very dim-sighted. Hearing bad.	Bad Teeth,
85	Richard Olliffon.	Born at Norway. No education.	Not remarkable.	32 years.	Cold.	60 years a.	Moderate	Never uſed tobacco.	Middling eye ſight. Hard of hearing.	Bad Teeth.
81	Peter Eager.	Cumberland, but removed to Ireland in his infancy.	Father 84 father's uncle 102.	14 years.	Warm.	50 years.	Very little.	Chews freely.	Rather dim-ſighted. Otherwiſe good.	Very bad Teeth.
82	Edward Collins.	Born and educated at Barking, Eſſex.	Not remarkable.	36 years.	Cold.	4 years.	Very freely	Chews freely.	Very dim-ſighted. Otherwiſe good.	Middling Teeth.
82	George Diffiny.	Born and educated Chiſwick, Middleſex.	Not remarkable.	20 years.	Both.	30 years.	Freely.	Chews freely.	Very dim ſighted. O herwiſe good.	Middling Teeth.
83	William Wright,	Born and educated at Briſtol.	Father 103,—mo. 90.	30 years	Warm.	24 years.	Freely.	Smokes freely.	Very hard of hearing.	Middling Teeth.
92	Edward Skinner.	Born and educated at Dartford, Kent.	Father 94.	2 years	Cold.	43 years.	Moderate.	Chews freely.	Very hard of hearing.	Bad Teeth.
98	Daniel M'Neal.	Born at Campbelton, Argyleſhire, N. B. and educated.	Not remarkable.	37 years.	Cold.	22 years.	Moderate.	Chews freely.	Dim'd, and bluiſh of one Eye.	Middling good Teeth,
83	Jeffrey Moore.	Born at Buntingford, in Hertfordſhire, and ed ucated.	Cannot tell.	10 years.	Cold	8 years.	Never uſed any.	Very little.	Dim-ſighted. Very infirm.	Bad Teeth.
87	Nathaniel Chapman.	Born at Taunton in Somerſet, and educated.	Not remarkable.	15 years.	Warm.	2 years.	Moderate.	Snuffs freely.	Dim ſighted. Very infirm.	Not a Tooth left.
81	Robert Hannaway.	Born at Edinburgh, and educated.	Grandfath r 104. Grandmother 100.	21 years.	Moſtly warm	49 years.	Moderate.	Snuff. freely.	Very deaf. Otherwiſe very good.	Front Teeth pretty good.
102	John Moore.	Born at Caſtlellions, in Cork, Ireland, and educated.	Grandfather 114. Father 105.	31 years.	Moſtly cold.	60 years.	Pretty freely.	Chews freely.	Rather dim ſighted Quite new Teeth—Voice.	Bad Teeth.
91	Daniel Coughlan.	Born in Cork, in Ireland, and educated.	Not remarkable.	37 years	Moſtly warm.	40 years.	Moderate.	Snuffs freely.	Very good Sight bad.	Good Teeth.
89	John Hutchins.	Born at Whitby, in Yorkſhire, and educated.	Grandmother 105.	22 years.	Moſtly warm.	46 years.	Moderate.	Chews freely.	Very ſhort of breath.	Not a Tooth left.
95	John Jackſon.	Born at Aberdeen, in Scotland, and educated.	Father 100.	9 years.	Moſtly cold.	50 years.	Freely.	Smokes freely.	Very infirm.	Not a Tooth left.
83	John Blackwell.	Born at Clare, in Ireland, and educated.	Mother 106.	16 years.	Both.	60 years.	Freely.	Snuffs freely.	Very good.	Not a Tooth left.
92	John M'Perſon.	Born at Stirling, in Argyleſhire, and educated.	Not remarkable.	24 years.	Moſtly warm.	22 years.	Freely.	Smokes freely.	Very dim-ſighted.	Middling good Teeth.
91	Thomas Lanldown	Born in Leadenhall-ſtreet, London, and educated.	Not remarkable.	14 years	Moſtly warm.	25 years.	Freely.	Chews freely.	Very good.	Not a Tooth left.
85	James Archer.	Born at St. Albans, Hertfordſhire, and educated.	Not remarkable.	12 years.	Moſtly warm.	11 years.	Freely.	Chews freely.	Dim ſighted and Palſy.	Not a Tooth left.
85	Adam Malcum.	Born at Liberton, in Mid-Lothian, and educated.	Not remarkable.	14 years	Moſtly warm.	19 years.	Moderate.	Chews freely.	Quite blind. Otherwiſe good.	Not a Tooth left.
84	Thomas Vaughan.	Born at Barking, in Eſſex, and educated.	Not remarkable.	14 years.	Moſtly warm.	34 years.	Freely.	Chews freely.	Dim ſighted.	Not a Tooth left.
80	John Catherick.	Born at Rotherhithe, in Surrey, and educated.	Not remarkable.	14 years.	Moſtly warm.	14 years.	Freely.	Smokes freely.	Very dim-ſighted. Otherwiſe good.	Bad Teeth.
81	Iſaac Rutter.	Born in Whitechapel, London, and educated.	Not remarkable.	21 years.	Moſtly warm.	4 years.	Freely.	Chews freely.	Very infirm. Very dim-ſighted.	Bad Teeth.
81	James Patch.	Born at Whitby in Yorkſhire, and educated.	Not remarkable.	8 years.	Moderate.	20 years.	Freely.	Chews freely.	Dim-ſighted. Very ſhort breath.	Bad Teeth.
84	John Gullam.	Born in South Wales, and educated.	Not remarkable. Father 104. Grandfather 106. Grandmother 102.	20 years.	Moſtly warm.	20 year.	Freely.	Chews freely.	Rather dim-ſighted.	Bad Teeth.
86	Peter Richardſon.	Born at Inverelk, Mid-lothian, N. B and educated.	Mother 96.	22 years.	Moderate.	Never married.	Freely.	Chews freely.	Palſy in his head.	Not a Tooth left.
87	James Dawſon.	Born Rotherhithe in Surrey, and educated.	Grandfather 110.	18 years.	Moſtly warm.	3 years.	Moderate.	Chews freely.	Very dim-ſighted, Very infirm.	Not a Tooth left.
89	Francis Knight.	Born at London, and educated.	Not remarkable.	17 years.	Moſtly warm.	6 years.	Freely.	Chews freely.	Good ſight. Very good.	Not a Tooth left.
87	Richard Maddox.	Born at Dublin in Ireland, and educated.	Not remarkable.	60 years.	Moſtly warm.	60 years.	Moderate.	Snuffs freely.	Dim-ſighted. Otherwiſe good.	Bad Teeth.
86	Thomas Cooper.	Born at Leith in Scotland, and educated.	Not remarkable.	24 years	Moſtly warm.	11 years.	Very little.	Chews freely.	Sight pretty good Good Appetite.	Bad Teeth.
90	John Bradley.	Born in the North of Ireland, and educated.	Not remarkable.	24 years.	Moſtly warm.	Never married.	Moderate	Chews freely.	Dim ſighted.	Bad Teeth.
94	Alexander Forbes.	Born in Aberdeen in Scotland, and educated.	Not remarkable.	42 years.	Moderate.	42 years.	Moderate.	Smokes freely.	Rather dim-ſighted, Otherwiſe good.	Bad Teeth.
93	John Welch.	Born at Dalkeith in Scotland, and educated.	Not remarkable.	29 years.	Moſtly warm.	Never married.	Freely.	Chews freely.	Very good.	Not a Tooth left.
95	Robert Caldwell.	Born at Luith in Scotland, and educated.	Not remarkable.	14 years	Moderate.	Never married.	Freely.	Chews freely.	Very dim-ſighted. Otherwiſe good.	Bad Teeth.
95	John Cummings.	Born at Limerick in Ireland, and educated.	Not remarkable.	24 years.	Moſtly warm.	35 years.	Freely.	Chews freely.	Bluiſh of one Eye. Otherwiſe good.	Bad Teeth.
82	Robert Pattle.	Born at Newfoundland, and educated.	Grandmother 118.	24 years	Moſtly cold.	50 years.	Moderate	Chews freely.	Dim-ſighted. Otherwiſe good.	Not a Tooth left.
89	George Taylor.	Born at Glaſgow in Scotland, and educated.	Not remarkable.	33 years.	Moſtly warm.	Never married	Freely.	Chews freely.	Bluiſh of one Eye. Otherwiſe good.	Bad Teeth.
85	Robert Toms.	Born at Winchcſter in Hampſhire, and educated.	Not remarkable.	27 years	Moſtly warm.	Never married.	Freely.	Chews freely.	Very dim-ſighted. Otherwiſe good.	Bad Teeth.
81	John Shuter.	Born in London, and educated.	Not remarkable.	14 years.	Moderate.	45 years.	Freely.	Chew freely.	Dim ſighted. Otherwiſe good.	Bad Teeth.
83	John Coverdale.	Born in Robinhood Bay, and educated.	Not remarkable.	18 years.	Moſtly cold.	5 years.	Freely.	Chews freely.	Very dim-ſighted. Very infirm.	Bad Teeth.
86	John Lloyd.	Born in Harfordweſt, South Wales, and educated.	Not remarkable.	15 years.	Moderate.	40 years.	Moderate.	Chews freely.	Keeps his bed. Very infirm. Very dim ſighted.	Bad Teeth.
83	William Hunter.	Born at Antrim in Ireland, and educated.	Not remarkable.	37 years.	Moſtly warm.	Never married.	Freely.	Snuffs freely.	Very dim ſighted. Very ſhort of breath.	Pretty good Teeth.
87	Frederick Bailey.	Born at Aſhburton in Devonſhire, and educated.	Not remarkable.	20 years.	Moſtly warm.	40 years.	Freely.	Chews freely.	Very dim-ſighted Memory bad.	Bad Teeth.
81	William Beaſon.	Born at Somerſet in Somerſetſhire, and educated.	Not remarkable.	17 years.	Moſtly warm.	5 years.	Freely.	Snuffs freely	Very deaf. Otherwiſe good.	Bad Teeth.

The ſtate of their Organs, and Mental Faculties.	*The ſtate of their Teeth.*
Very dim-ſighted. Hearing bad.	Bad Teeth.
Middling eye-ſight. Hard of hearing.	Bad Teeth.
Rather dim-ſighted. Otherwiſe good.	Very bad Teeth.
Very dim-ſighted. Otherwiſe good.	Middling Teeth.
Very dim ſighted. Otherwiſe good.	Middling Teeth.
Very hard of hearing.	Middling Teeth.
Very hard of hearing.	Bad Teeth.
Ditto, and blind of one Eye.	Middling good Teeth.
Dim-ſighted. Very infirm.	Bad Teeth.
Dim-ſighted. Very infirm.	Not a Tooth left.
Very deaf. Otherwiſe very good.	Front Teeth pretty good.
Rather dim-ſighted. 4 new Teeth—3 loſt.	Bad Teeth.
Very good.	Good Teeth.
Sight bad.	Not a Tooth left.
Very ſhort of breath.	Not a Tooth left.
Very infirm.	Not a Tooth left.
Very good.	Not a Tooth left.
Very dim-ſighted.	Middling good Teeth.
Very good.	Not a Tooth left.
Dim-ſighted and Palſy.	Not a Tooth left.
Quite blind. Otherwiſe good.	Not a Tooth left.
Dim ſighted.	Not a Tooth left.
Very dim-ſighted. Otherwiſe good.	Bad Teeth.
Very infirm. Very dim-ſighted.	Bad Teeth.
Dim-ſighted. Very ſhort breath.	Bad Teeth.
Rather dim-ſighted.	Bad Teeth.
Palſy in his head.	Not a Tooth left.
Very dim-ſighted, Very infirm.	Not a Tooth left.
Good ſight. Very good.	Not a Tooth left.
Dim-ſighted. Otherwiſe good.	Bad Teeth.
Sight pretty good. Good Appetite.	Bad Teeth.
Dim ſighted.	Bad Teeth.
Rather dim-ſighted. Otherwiſe good.	Bad Teeth.
Very good.	Not a Tooth left.
Very dim-ſighted. Otherwiſe good	Bad Teeth.
Blind of one Eye. Otherwiſe good.	Bad Teeth.
Dim-ſighted. Otherwiſe good.	Not a Tooth left.
Blind of one Eye. Otherwiſe good.	Bad Teeth.
Very dim-ſighted. Otherwiſe good.	Bad Teeth.
Dim-ſighted Otherwiſe good.	Bad Teeth.
Very dim-ſighted. Very infirm.	Bad Teeth.
Keeps his bed. Very infirm. Very dim ſighted.	Bad Teeth.

unneceſſary to touch upon that branch of the inquiry. He has very obligingly, however, communicated the following additional obſervations, connected with the ſubject of longevity in general.

1. The number of In-penſioners being 2,410, and the number of thoſe who are from 80 years of age and upwards being 96; the proportion of the aged to the whole is only as $\frac{10}{976}$ leſs than $\frac{1}{25}$.

2. Some uſe tobacco for particular complaints, which they think are relieved by the uſe of it, or uſe ſnuff; and the reſt ſay that they cannot do without it.

3. John Moore (the oldeſt man in the houſe) ſays, that he has had four new FORE teeth within theſe five years; one of which he has loſt he knows not how. This is commonly counted a great mark of old age.

4. The proportion of aged marines is $\frac{12}{976}$, or $\frac{1}{8}$ of the whole number of perſons above 80 years of age, in the Hoſpital.

5. The number of Out-penſioners is about 2,500, to whoſe ages when they were admitted, the number of years they have been on the liſt being added, it appears there are only 23 from 80 years of age and upwards; a ſufficient proof of the great attention paid to the health of the In-penſioners at this excellent inſtitution.

6. The number of ruptured men among the In-penſioners, on the 3d of May, was 161, or $\frac{1}{15}$, the number being 2,410. Among the Out-penſioners, amounting to 2,500, the number was only about 50, or nearly $\frac{1}{40}$.

ROYAL

ROYAL HOSPITAL AT GREENWICH.

Deaths of Pensioners from the 1st of January 1782 *to the* 31*st of December* 1798, *inclusive, the Complement being* 2350.

Year.	*January.*	*February.*	*March.*	*April.*	*May.*	*June.*	*July.*	*August.*	*September.*	*October.*	*November.*	*December.*	*Number in each year.*
1782	16	19	15	21	24	31	18	16	16	16	17	16	228
—83	18	15	17	14	12	17	13	15	16	17	15	19	188
—84	17	25	21	25	22	14	13	6	6	10	10	17	186
—85	20	16	14	16	14	18	21	19	15	15	10	17	195
—86	11	20	20	12	13	20	8	18	15	17	24	8	186
—87	36	14	12	20	11	16	14	11	14	16	20	21	212
—88	13	15	22	20	13	11	16	15	15	14	12	26	192
—89	27	23	15	18	16	14	15	13	18	21	12	11	203
—90	15	12	10	14	22	11	15	21	10	13	21	15	179
—91	18	19	18	20	22	25	21	14	12	16	13	20	218
—92	21	15	24	11	14	16	13	12	12	13	17	20	188
—93	23	15	17	10	19	8	14	11	13	17	15	16	178
—94	33	15	13	16	14	17	16	14	19	13	13	20	209
—95	32	27	45	24	24	15	15	12	18	14	11	11	248
—96	19	13	10	23	17	12	8	13	10	13	12	22	173
—97	14	25	13	19	26	20	17	9	13	20	23	21	220
—98	18	21	25	20	20	17	15	16	17	14	15	24	222
Total	351	309	311	303	303	282	252	235	239	259	260	314	17)3425
													201 $\frac{8}{17}$

ROYAL HOSPITAL AT GREENWICH.

Deaths of Pensioners from the 1st of January 1799 *to the* 31*st of December* 1801, *inclusive, the Complement being* 2410.

Year.	*January.*	*February.*	*March.*	*April.*	*May.*	*June.*	*July.*	*August.*	*September.*	*October.*	*November*	*December.*	*Number in each year.*
1799	23	20	23	23	36	16	12	11	20	14	12	26	236
1800	25	19	17	19	8	15	7	15	26	23	19	15	208
1801	18	9	15	20	9	15	11	15	16	13	16	17	174
Total	66	48	55	62	53	46	30	41	62	50	47	58	3)618
													206

The

The following obſervations have occurred to Dr. Jameſon on the two preceding tables.

That during the ſpace of twenty years, the number of annual deaths was very ſimilar, varying very little in any year, or in any month of theſe years. And as it appears no uncommon incident occurred during that time to alter the natural order, we have a tolerably certain eſtimate, which may be ſaid to be 203 annual deaths out of 2400 penſioners.

That theſe men, who were moſtly in advanced years, died in greateſt number in the three winter months, reckoning December the firſt; and in the ſmalleſt proportion, in the three ſummer months, reckoning June the firſt, and that the ſpring was more mortal than autumn.

Viz. From November till March 1146.
—June 1087.
—Sept. 886.
—Dec. 924.

Table of the Diet at Greenwich Hoſpital.

Days.	Bread. lb.	Beer. quarts.	Beef. lb.	Mutton. lb.	Butter. lb.	Cheeſe. lb.	Peaſe. pints.
Sunday	1	2	—	1	—	$\frac{1}{4}$	—
Monday	1	2	1	—	—	$\frac{1}{4}$	—
Tueſday	1	2	—	1	—	$\frac{1}{4}$	—
Wedneſday	1	2	—	—	$\frac{1}{16}$	$\frac{1}{2}$	$\frac{1}{2}$
Thurſday	1	2	1	—	—	$\frac{1}{2}$	—
Friday	1	2	—	—	$\frac{1}{16}$	$\frac{1}{2}$	$\frac{1}{2}$
Saturday	1	2	1	—	—	$\frac{1}{4}$	—
Total *per* week.	7	14	3	2	$\frac{2}{16}$	$2\frac{1}{4}$	1

Broth is made of the meat.

The diet of the ſick varies at the diſcretion of the phyſician.

It appears by the Table of Diet, that the allowance is well calculated for the purpoſes of health, and very much reſembles the victualling of his majeſty's navy, two banian days in the week.—The proportions of animal and vegetable food are equally balanced.

XLI. *De-*

XLI. *Description of an improved Gas-holder, by Dr.* WARWICK.

SIR, *To Mr. Tilloch.*

AS ſimplicity and cheapneſs are objects of conſiderable importance in the conſtruction of chemical apparatus, I ſhall make no apology for recommending to your readers a leſs expenſive alteration in the air-holder of Mr. Watt, than that deſcribed by Mr. Pepys in your laſt number. I contrived it upwards of two years ſince, and find it anſwers every purpoſe for which it was intended. A ſtop-cock, ſoldered to the ſhorter tube in the top of the gas-holder, and a rim ſufficiently deep to permit the water to riſe an inch above the ſtop-cock, will enable thoſe fond of pneumatic experiments to transfer oxygen (or any other) gas with the utmoſt readineſs to any veſſel they pleaſe. (See Fig. 3. Plate V.) The ſtop-cock has no ſcrew, the blow-pipe having a ſocket fitting the tube with ſufficient accuracy to prevent the eſcape of air. A peruſal of the communication of Mr. Pepys will render a more minute deſcription unneceſſary. Thoſe perſons to whom expenſe is of no conſequence will moſt likely prefer that contrived by Mr. Pepys, which is in ſome reſpects, perhaps, more convenient than that of which I have ſent you a ſketch; but of this every one muſt judge for himſelf. I remain, Yours, &c.

Rotherham, Aug. 9, 1802. T. O. WARWICK.

XLII. *Remarks on the* CLATHRUS *cancellatus* (Linn.) *and two other Species of Fungus. By* B. M. FORSTER, *Eſq. Communicated by the Author.*

THE very near reſemblance which the CLATHRUS *cancellatus* bears in ſeveral reſpects to the PHALLUS *impudicus* and PHALLUS *caninus*, appears ſufficiently ſtrong to juſtify the arrangement of them all under one genus, although not ſo conſidered by Linnæus, and I have ventured to form generic and ſpecific characters as follow:

Generic Character.

CLATHRUS.

Volva coriacea. *Corpus* cavus, celluloſus, pertuſus. *Semina* in glutine immerſa.

Specific Characters.

CL. *cancellatus*, corpore globoſo, feneſtrato.

CL. *pileatus*, corpore cylindrico, pileo favoſo.

CL. *capitulatus*, corpore cylindrico, capitulo corrugato.

For

For good figures of the C. *cancellatus*, Micheli may be referred to, and for the two latter, Curtis's Fl. Lond. and Sowerby's Engliſh Fungi, called in both publications PHALLUS.

I am not aware that any other Fungus will arrange with the above three ſpecies, although ſome have been placed under the genus PHALLUS, by Linnæus and other botaniſts, which have very little agreement with the P. *impudicus* and P. *caninus* of thoſe authors.

XLIII. *An Attempt towards a Theory of the Reſiſtance experienced by two and four-wheeled Carriages on different Kinds of Roads; and to determine the Circumſtances under which the one are preferable to the other.* By NICHOLAS FUSS, *Profeſſor of the higher Mathematics at Peterſburgh, Member of the Imperial Academy of Sciences, &c.*

[Continued from p. 122.]

SECOND DIVISION.

Of the Reſiſtance on ſolid and uneven Roads.

I. *Four-wheeled Carriages.*

Section 19.

IF the road AB, Plate II. fig. 4. be naturally rough and ſtony, or paved artificially, or covered in ſome places with trees laid acroſs it, new impediments ariſe from theſe inequalities, and the reſiſtance found in the preceding diviſion, ſection 9, which takes place here alſo, acquires an increaſe, which is determined in the following manner:

Let the wheel touch in G and G′ two equally large and ſolid inequalities of the road, and for the fore-wheels let the angle $GOG' = 2\varphi$, but for the hind-wheels $GOG' = 2\psi$. Now as a part of the moving power OV, which we ſhall call OU = K, muſt be employed to overcome a part of the power of gravity acting in a direction perpendicular to AB, which is $(\frac{1}{2}P + p)\cos.\alpha$, and to raiſe the fore-axle together with its part of the load over the fixed point G, the momentum of theſe powers OU.GU and OR.GR muſt be equal to each other; that is, $K.GO\cos.\varphi = (\frac{1}{2}P+p)\cos.\alpha.\ GO\ \text{ſin.}\ \varphi$; ſo that the increaſe of reſiſtance ariſing from this impediment will be for the fore-wheels $K = (\frac{1}{2}P+p)\cos.\alpha\ \text{tang.}\ \varphi$. A ſimilar increaſe will be found for the hind-wheels $= (\frac{1}{2}P+p')\cos.\alpha\ \text{tang.}\ \psi$. Conſequently the whole reſiſtance on roads of the ſecond claſs for four-wheeled carriages is:

$$R = \tfrac{1}{2}(m+n)\lambda P\cos.\alpha + (P+p+p')\ \text{ſin.}\ \alpha + (\tfrac{1}{2}P+p)\cos.\alpha\ \text{tang.}\ \varphi + (\tfrac{1}{2}P+p')\cos.\alpha\ \text{tang.}\ \psi$$

II. *Two-*

II. *Two-wheeled Carriages.*

Section 20.

The reſiſtance found in the preceding diviſion, ſection 12, for carriages of this kind, acquires here an increaſe, which, if we make the angle GOG′ = 2ω, will be found in the ſame manner as in the preceding ſection = (P + π) cos. α tang. ω. The whole reſiſtance for two-wheeled carriages on roads of the ſecond claſs will therefore be expreſſed as follows:

$$R' = \mu\lambda P \cos.\alpha + (P + \varepsilon P + \pi) \text{ ſin. } \alpha + (P + \pi) \cos.\alpha \text{ tang. } \omega$$

III. *Compariſon of the two Kinds of Carriages.*

Section 21.

If the compariſon be made in general according to the five different points of view mentioned in the 16th ſection, it will be found that four-wheeled carriages are preferable to two-wheeled when any of the five following conditions take place:

1ſt, $$\frac{m+n-2\mu}{2} < \frac{(\varepsilon P+\pi-p-p')\tan.\alpha + (P+\pi)\tan.\omega}{\lambda P} - \frac{(\frac{1}{2}P+p)\text{ tang. }\varphi - (\frac{1}{2}P+p')\text{ tang. }\psi}{\lambda P}$$

2d, $$p+p'-\pi < \varepsilon P - \frac{(m+n-2\mu)\frac{1}{2}\lambda P + (P+\pi)\tan.\omega}{\text{tang. }\alpha} - \frac{(\frac{1}{2}P+p)\text{ tang. }\varphi - (\frac{1}{2}P+p')\text{ tang. }\psi}{\text{tang. }\alpha}$$

3d, $$P > \frac{(p+p'-\pi)\text{ tang. }\alpha + p\text{ tang. }\varphi + p'\tan.\psi - \pi\text{ tang. }\omega}{\varepsilon\text{ tang. }\alpha + \text{tang. }\omega - \frac{1}{2}\text{ tang. }\varphi - \frac{1}{2}\psi - \frac{1}{2}\lambda(m+n-2\mu)}$$

4th, $$\varepsilon > \frac{(m+n-2\mu)\frac{1}{2}\lambda P + (p+p'-\pi)\text{ tang. }\alpha + (\frac{1}{2}P+p)}{P\text{ tang. }\alpha} \cdot \frac{\text{tang. }\varphi + (\frac{1}{2}P+p')\text{ tang. }\psi - (P+\pi)\text{ tang. }\omega}{P\text{ tang. }\alpha}$$

5th, $$\text{Tang. }\alpha > \frac{(m+n-2\mu)\frac{1}{2}\lambda P + (\frac{1}{2}P+p)\text{ tang. }\varphi}{\varepsilon P+\pi-p-p'} + \frac{(\frac{1}{2}P+p')\text{ tang. }\psi - (P+\pi)\text{ tang. }\omega}{\varepsilon P+\pi-p-p'}$$

EXAMPLE I.

Section 22.

Let the road be compoſed of round pieces of timber ſix inches in diameter laid acroſs it, and let α = 0. Let the mean diameter of the fore and hind axle-trees of the four-wheeled carriages be $3\frac{1}{4}$ inches; that of the axles of the two-wheeled carriages $3\frac{3}{4}$; and the diameter of the wheels in the

same order, 26, 39, and 45 inches; so that $m = \frac{1}{8}$, $n = \frac{1}{7}$, and $\mu = \frac{1}{12}$: also, let P = 1000 lib., p = 74 lib., $p' = 106$ lib., and $\pi = 130$ lib.; and let the coefficient of the friction be $\lambda = \frac{2}{9}$. In the last place, as TG = TF = 3 inches, we shall have for the wheels in the above order TO = 16, $\frac{45}{2}$ and $\frac{51}{2}$ inches, and because sin. TOF = $\frac{TF}{TO}$; the angle TOF, that is to say, $\varphi = 10° 48'$; $\psi = 7° 40'$; $\omega = 6° 45°$. From these elements we obtain,

$\frac{1}{2}(m + n) \lambda P = 23{\cdot}148$
$(\frac{1}{2} P + p)$ tang. $\varphi = 109{\cdot}496$
$(\frac{1}{2} P + p)$ tang. $\psi = 81{\cdot}575$

$R = 214{\cdot}219$

$\mu \lambda P = 18{\cdot}518$
$(P + \pi)$ tang. $\omega = 133{\cdot}744$

$R' = 152\ 262$

For a horse, then, whose strength M = 400 lib. and velocity G = 13 feet on such a road, we have $g = 3{\cdot}484$ feet, and $g' = 4{\cdot}979$ feet in a second.

It might be conjectured that four-wheeled carriages, the fore-wheels being so small, would experience a resistance considerably greater than the two-wheeled. Were $m = n = \frac{1}{12}$, and $p = p' = 106$, we should have R = 181·669, and $g = 4{\cdot}238$.

Example II.

Section 23.

Let the road be steep and composed of stones, the angle of elevation being $\alpha = 14°$, and let the pavement be of such a nature, that the distance between the points of contact G, G′ = 3 inches, consequently the angle $\varphi = 5° 45'$; $\psi = 4° 6'$, and $\omega = 3° 49'$. Let the burden be P = 1800 lib., the mean diameter of the axle-trees of the fore-wheels = 3 inches, of the hind-wheels $3\frac{1}{2}$ inches, that of the two-wheeled carriages $3\frac{1}{4}$ inches; let the diameter of the wheels in the same order be 30, 42, and 45 inches; so that $m = \frac{1}{9}$, $n = \frac{1}{12}$, and $\mu = \frac{1}{14}$. The weight of the wheels we shall suppose to be p = 80 lib. $p' = 110$ lib., and $\pi = 120$ lib. In the last place, let $\lambda = \frac{1}{3}$, and $\varepsilon = \frac{1}{24}$. Hence we obtain

$\frac{1}{2}(m + n) \lambda P \cos. \alpha = 33{\cdot}960$
$(P + p + p')$ sin. $\alpha = 481{\cdot}425$
$(\frac{1}{2} P + p) \cos. \alpha$ tang. $\varphi = 95{\cdot}750$
$(\frac{1}{2} P + p) \cos. \alpha$ tang. $\psi = 70{\cdot}247$

$R = 681{\cdot}382$

$\mu \lambda P$

$$\mu\lambda P \cos.\alpha = 29{\cdot}109$$
$$(P + \varepsilon P + \pi) \text{ ſin. } \alpha = 482{\cdot}634$$
$$(P + \pi) \cos.\alpha \text{ tang. } \omega = 124{\cdot}282$$
$$R' = 636{\cdot}025$$

Three horſes, therefore, whoſe ſtrength is $M = 1200$ lib. and their velocity on this kind of road $G = 10$ feet, could draw the burden $P = 1800$ lib. on a four-wheeled carriage at the rate of $g = 2{\cdot}47$ feet per ſecond, and on a two-wheeled carriage about $g' = 2{\cdot}72$ feet.

Section 24.

On a horizontal road of the above nature we ſhall have for the ſame carriages and load $R = 206{\cdot}08$ and $R' = 158{\cdot}09$. For a horſe therefore whoſe ſtrength $M = 400$ lib., and velocity on this horizontal road $G = 15$ feet, we ſhall have $g = 4{\cdot}23$ and $g' = 5{\cdot}58$ feet.

Third Division.

Of the Reſiſtance on ſoft and even Roads.

Section 25.

If the ſurface of the road be compoſed of ſoft ſand, ſlate, earth, clay, dirt, &c. the wheels will ſink into it, and the depth to which they ſink will be greater the ſofter and more fluid the matter is of which the road conſiſts.

Now as the increaſe of reſiſtance depends on the depth to which the wheels ſink, and as this depth depends on the nature of the matter, that is to ſay, its hydroſtatic power, which can be determined only by experiment, I ſhall aſſume that a priſmatic body the thickneſs of which is dd ſquare inches and its weight 9 lib. ſinks merely by its gravity c inches deep in the fluid matter, or diſplaces ddc cubic inches of it before it comes into equilibrium: this matter, then, in regard to hydroſtatic power produces the ſame effect as would be produced by an aqueous fluid a cubic foot of which weighs $\frac{12^3 q}{ddc}$ lib.

A load Q, Pl. II. fig. 5. will preſs down both wheels on the axis O till they have diſplaced $\frac{ddcQ}{q}$ cubic inches of the fluid matter. If FR be the depth to which the wheels ſink, and π' the circumference of a circle whoſe diameter $= 1$, the ſuperficial content of the ſunken ſegment GFG′R $= GO^2 \left(\frac{\pi'. \sphericalangle GOR}{180^\circ} - \frac{1}{2} \text{ ſin. } GOG'\right)$. And if the felloes be

be b inches broad, we shall have for both wheels:

$$2b\,GO^2\left(\frac{\pi'.\sphericalangle GOR}{180^\circ} - \tfrac{1}{2}\sin.\,GOG'\right) = \frac{ddQ}{q}.$$

Hence we find,

$$\frac{\pi'.GOR}{90^\circ} - \sin.\,GOG' = \frac{ddQ}{bq.GO^2};$$

from which equation the angle GOR necessary for determining the resistance is found.

I. *Four-wheeled Carriages.*

Section 26.

As the wheels in this case have sunk to the points G, G′ of their circumference, there arises in the point G an impediment to the motion, which will be greater or less according as the surface of the road is covered with more or less fluid matter; that is, according to the greater or less extent of the angle which the sides of as steep an accumulation as possible of this matter forms with the level surface. This angle, which gives the most convenient measure of the fluidity, I shall in future call β.

Now if GFG′ were an excavation in a perfectly solid road, G would oppose the moving power OV in consequence of the power of gravity OQ = S with a power OR = S cos. α, the momentum of which is OR.GR = S cos. α. GO sin. GOR. If the part of the moving power employed for this purpose be K, its momentum K.GU = K.GO cos. GOR; so that K = S cos. α tang. GOR. If the angle for the fore-wheels be GOR = ξ, and for the hind-wheels GOR = η, the resistance for the former = $(\frac{1}{2}P + p)$ cos. α. tang. ξ, and for the latter = $(\frac{1}{2}P + p')$ cos. α tang η; consequently, the increase of resistance for the four-wheeled carriages = cos. α $[(\frac{1}{2}P + p)$ tang. $\xi + (\frac{1}{2}P + p')$ tang. $\eta]$. With this power G opposes a resistance as a fixed point, but, as a fluid, it yields and opposes a less power the greater its fluidity, the coefficient of which is sin. β. The increase of resistance on roads of this kind is therefore = cos. α sin. β $[(\frac{1}{2}P + p)$ tang. $\xi + (\frac{1}{2}P + p')$ tang. $\eta]$; consequently the whole resistance for four-wheeled carriages:

$$R = \tfrac{1}{2}(m + n)\,\lambda P \cos.\,\alpha + (P + p + p')\sin.\,\alpha + \cos.\,\alpha \sin.\,\beta\,[(\tfrac{1}{2}P + p)\,\text{tang.}\,\xi + (\tfrac{1}{2}P + p)\,\text{tang.}\,\eta.]$$

II. *Two-wheeled Carriages.*

Section 27.

If we make the angle GOR = ϑ, it will be found in the

ſame manner as in the preceding ſection, that the increaſe of reſiſtance on roads of this claſs is $= (P + \pi) \cos. \alpha \text{ fin. } \beta \text{ tang. } \vartheta$; and the whole reſiſtance for two-wheeled carriages will be,

$$R' = \mu\lambda P \cos. \alpha + (P + \varepsilon P + \pi) \text{ fin. } \alpha \\ + (P + \pi) \cos. \alpha, \text{ fin. } \pi, \text{ tang. } \vartheta.$$

III. *Obſervations on theſe Formulæ R and R'.*

Section 28.

Theſe expreſſions for R and R' as above found contain, as we ſhall ſoon ſee, a complete ſolution of the problem, as they anſwer for all the three claſſes of roads.

1ſt, For ſolid and even roads where $\xi = 0$, $\eta = 0$, $\vartheta = 0$, and $\beta = 90°$, they give for R and R' the ſame values as thoſe found for reſiſtance in the firſt diviſion.

2d, For ſolid and uneven roads where $\xi = \varphi$, $\eta = \psi$, $\vartheta = \omega$, and $\beta = 90°$, we have the ſame values for R and R' as thoſe found in the ſecond diviſion.

3d, For roads with ſtanding water on a ſolid bottom (which, however, muſt not reach to the ſpokes, becauſe in this caſe the reſiſtance muſt be determined in another manner), where $\beta = 0$, we ſhall have R and R' as in the firſt diviſion. In this caſe, no perceptible increaſe of reſiſtance ariſes: on the other hand, on ſuch roads G and conſequently V is leſs than on roads of the firſt claſs.

4th, When one of the angles ξ, η, or ϑ, is a right angle; that is, when P is ſo great that the wheels ſink up to the axle in the ſoft ſurface, the reſiſtance becomes infinitely great, except in that caſe only where the fluid is very thin, and $\beta = 0$; in which caſe inſtead of an infinitely great reſiſtance we ſhall have only an indefinite increaſe $= 0.\infty$, which cannot be determined from the grounds mentioned in the third obſervation.

In the laſt place, it is to be obſerved in regard to theſe expreſſions,

5th, That when the ſoft tender ſurface has a ſolid bottom, and is not ſo deep that the wheels can penetrate into it according to the laws of hydroſtatics, the angle GOR muſt not be determined according to the abſolute ſinking, but according to the depth of the ſolid bottom.

6th, That for leſs fluid matters, ſuch as moiſt ſand, moiſt earth, ſtiff clay, dirt, &c. in the expreſſion for the reſiſtance of four-wheeled carriages, R the laſt member for the hind-wheels $(\frac{1}{2} P + p') \cos. \alpha$, fin. β, tang. η, vaniſhes, becauſe theſe wheels run in the ruts formed by the fore-wheels.

IV. *Com-*

IV. *Comparison between the two Kinds of Carriages.*

Section 29.

On roads of this class, four-wheeled carriages are to be preferred to two-wheeled, when one of the five following conditions takes place:

1st, $\frac{m+n-2\mu}{2} < \left\{\begin{array}{l} \frac{(\varepsilon P+\pi-p-p')\text{ t. }\alpha+\text{fin. }\beta\,[(P+\pi)\text{t.}\vartheta}{\lambda P} \\ \frac{-(\frac{1}{2}P+p)\text{ tang. }\xi-(\frac{1}{2}P+p')\text{ tang. }\eta}{\lambda P} \end{array}\right.$

2d, $p+p-\pi < \varepsilon P-\left\{\begin{array}{l} \frac{(m+n-2\mu)\,\frac{1}{2}\lambda P+\text{fin. }\beta\,[(P+\pi)\text{ t. }\vartheta}{\text{tang. }\alpha} \\ \frac{-(\frac{1}{2}P+p)\text{ tang. }\xi-(\frac{1}{2}P+p')\text{ tang. }\eta]}{\text{tang. }\alpha} \end{array}\right.$

3d, $P > \frac{(p+p'-\pi)\text{ t. }\alpha+\text{fin. }\beta\,(p\text{ t. }\xi+p'\text{ t. }\eta-\pi\text{ t. }\vartheta)}{\varepsilon\text{ t. }\alpha+\text{fin. }\beta\,[\text{t. }\vartheta-\frac{1}{2}\text{t. }\xi-\frac{1}{2}\text{t. }\eta]-\frac{1}{2}\lambda\,(m+n-2\mu)}$

4th, $\varepsilon > \left\{\begin{array}{l} \frac{(m+n-2\mu)\,\frac{1}{2}\lambda P+(p+p'-\pi)\text{ tang. }\alpha+\text{fin. }\beta}{P\text{ tang. }\alpha} \\ \frac{[(\frac{1}{2}P+p)\text{ tang. }\xi+(\frac{1}{2}P+p')\text{ tang. }\eta-(P+\pi)\text{ tang. }\vartheta]}{P\text{ tang. }\alpha} \end{array}\right.$

5th, Tang. $\alpha > \left\{\begin{array}{l} \frac{(m+n-2\mu)\,\frac{1}{2}\lambda P+\text{fin. }\beta\,[(\frac{1}{2}P+p)\text{ t. }\xi}{\varepsilon P+\pi-p-p'} \\ \frac{+(\frac{1}{2}P+p')\text{ tang. }\eta-(P+\pi)\text{ tang. }\vartheta]}{\varepsilon P+\pi-p-p'} \end{array}\right.$

That these five conditions are general, and contain the conditions found for the two classes before treated, section 16 and section 17, it is superfluous to mention, after what has been said in the first two remarks of the preceding section.

Application to some determinate Cases.

Example I.

Section 30.

I poured very dry coarse red sand, Pl. II. fig. 6. after I had found the angle $\beta = 30^{\circ}\,42'$ (that is to say, AB = 16 inches and CD = $4\frac{1}{2}$ inches), into a vessel, and, smoothing the surface of it after each experiment by shaking it so as to obtain the same degree of softness, I took a steel rod weighing 5 lib., which I had caused to be constructed for magnetic experiments, and which was just an inch square, and pushed it several times into the sand in a gentle manner, to prevent the acquired velocity from making it sink deeper than the equilibrium sought for. Sixteen experiments of this kind, in which the greatest difference did not amount to half a line,

gave as a medium of the sinking $\frac{7}{24}$ inches; so that $ddc = \frac{7}{24}$ inches, and $q = 5$ lib.

Let the road consist of such soft sand; let the inclination $\alpha = 4°$; the load $P = 1200$ lib., the weight of the wheels $p = 84$ lib. $p' = 110$ lib., $\pi = 132$ lib.; their diameter in the same order as before, $31\frac{1}{2}$, 42, and 49 inches. Also let $m = \frac{1}{9}$, $n = \frac{1}{12}$, $\mu = \frac{1}{14}$, $\lambda = \frac{1}{5}$; $OS = 2\frac{6}{7}$ feet and $OI = 12$ feet; so that $\varepsilon = \frac{1}{60}$. In the last place, let $b = 3$ inches, consequently,

$$\frac{\pi'\xi}{90°} - \text{sin. } 2\xi = 0{\cdot}05361, \text{ and } \xi = 19° 47'$$

$$\frac{\pi'\eta}{90°} - \text{sin. } 2\eta = 0{\cdot}03130, \text{ and } \eta = 16° 30'$$

$$\frac{\pi\vartheta}{90°} - \text{sin. } 2\vartheta = 0{\cdot}04315, \text{ and } \vartheta = 18° 23'$$

$\frac{1}{2}(m + n)\lambda P \cos. \alpha$	$= 23{\cdot}276$
$(P + p + p') \text{ sin. } \alpha$	$= 97{\cdot}242$
$(\frac{1}{2}P + p) \cos. \alpha, \text{ sin. } \beta, \text{ tang. } \xi$	$= 125{\cdot}303$
$(\frac{1}{2}P + p') \cos. \alpha, \text{ sin. } \beta, \text{ tang. } \eta$	$= 107{\cdot}112$
	$R = 352{\cdot}933$
$\mu\lambda P \cos. \alpha$	$= 17{\cdot}101$
$(P + \varepsilon P + \pi) \text{ sin. } \alpha$	$= 94{\cdot}311$
$(P + \pi) \cos. \alpha, \text{ sin. } \beta, \text{ tang. } \vartheta$	$= 225{\cdot}450$
	$336{\cdot}862$

If we suppose for two horses $M = 800$ and $G = 11$ feet, we shall have $g = 3{\cdot}696$ feet and $g' = 3{\cdot}861$ feet in a second.

However well the two-wheeled carriages may be constructed, however small the burden, the inclination of the road, and the height of the centre of gravity, the resistance is only a little less than for four-wheeled carriages. To show how much depends on the proportion of the wheels, and particularly in regard to carriages of this kind, I shall in the following examples change only the wheels of the two-wheeled carriages.

Example II.

Section 31.

Let every thing be as before, only for the two-wheeled carriages let $GO = 16$ inches, $\pi = 85$ lib., and $\mu = \frac{7}{64}$; therefore $\vartheta = 24° 15'$, and

$\mu\lambda P \cos. \alpha$	$= 26{\cdot}186$
$(P + \varepsilon P + \pi) \text{ sin. } \alpha$	$= 91{\cdot}032$
$(P + \pi) \cos. \alpha, \text{ sin. } \beta, \text{ tang. } \vartheta$	$= 294{\cdot}808$
	$412{\cdot}026$

Therefore

Therefore we ſhall have as before R = 352·933 lib., but R′ = 412·026 lib.; conſequently $g = 3{\cdot}696$ feet, and $g' = 3{\cdot}102$ feet.

Example III.

Section 32.

After a ſeries of ſimilar experiments with ſomewhat coarſer and very moiſt red ſand, I found $\beta = 43^\circ\ 19'$, and $c = \frac{5}{12}$ inch at a medium. But it is to be obſerved that the impreſſions made by immerſing the ſteel rod did not diſappear as from the above dry ſand, but remained after it was drawn out; and therefore after each experiment I was obliged to make the ſand even and ſoft by ſhaking it, and to render its ſurface ſmooth by a ſlight preſſure proportioned to the exact meaſurement of the depth; by which means it loſt a little of its natural ſoftneſs. When I placed the rod again in the remaining impreſſion it did not become deeper. Hence follows what we are taught by experience in general in regard to moiſt ſand, moiſt earth, thick mud, &c. that the hind-wheels when they revolve in the ruts formed by the fore-wheels do not make them deeper, and conſequently experience no reſiſtance from ſinking down; ſo that in the value of R, ſection 26, found for four-wheeled carriages, in ſuch caſes the laſt member $(\frac{1}{2}\,P + p)$ cos. α, ſin. β, tang. η vaniſhes.

Let us ſuppoſe then, as in the firſt example, ſection 30, that the angle $\alpha = 4^\circ$ the weight of the wheels, $p = 84$ lib., $p' = 110$ lib., $\pi = 132$ lib.; and their ſemidiameter in the ſame order, GO = $15\frac{1}{4}$, 21, $24\frac{1}{2}$ inches, and $b = 3$ inches; alſo let $m = \frac{1}{9}$, $n = \frac{1}{12}$, $\mu = \frac{1}{14}$, $\lambda = \frac{1}{5}$, $\varepsilon = \frac{1}{6\cdot 6}$, and $g = 5$ lib. If the load be P = 900 lib., and $ddc = \frac{5}{12}$ cubic inches, we ſhall have

$$\frac{\pi\,\xi}{90^\circ} - \text{ſin. } 2\xi = 0{\cdot}05980, \text{ and } \xi = 20^\circ\ 32'$$

$$\frac{\pi'\eta}{90^\circ} - \text{ſin. } 2\eta = 0{\cdot}03527, \text{ and } \eta = 17^\circ\ 10'$$

$$\frac{\pi'\vartheta}{90^\circ} - \text{ſin. } 2\vartheta = 0{\cdot}04776, \text{ and } \vartheta = 19^\circ\ 10'$$

$\frac{1}{2}\,(m+n)\,\lambda$ P cos. α	=	17·457
$(P + p + p')$ ſin. α	=	76·313
$(\frac{1}{2}\,P + p)$ cos. α, ſin. β, tang. ξ	=	136·878
	R =	230·648
$\mu\,\lambda$ P cos. α	=	12·826
$(P + \varepsilon\,P + \pi)$ ſin. α	=	73·035
$(P + \pi)$ cos. α, ſin. β, tang. ϑ	=	243·414
	R′ =	329·275

If for a horfe on this road M = 400 lib. and G = 12½ feet, we ſhall have $g = 3{\cdot}012$ and $g' = 1{\cdot}162$ feet in a ſecond.

Alſo if the hind-wheels do not run exactly in the ruts formed by the fore-wheels, and if the member $(\frac{1}{2} P + p) \cos. \alpha$, ſin. β, tang $\eta = 118{\cdot}389$, cannot be entirely omitted, we ſhall ſtill have $R < R'$ even when only the fourth part of it vaniſhes.

[To be continued.]

XLIV. *Some Account of* Edward Jenner, *M. D.*

THIS gentleman, who has diſtinguiſhed himſelf ſo much in the annals of medicine by bringing forward the vaccine inoculation to public notice, and who has been thought worthy of national remuneration on that account, is a ſon of the Rev. Stephen Jenner, formerly vicar of Berkley in Glouceſterſhire, a man highly reſpected by all thoſe who had the pleaſure of his acquaintance. Edward was born about the year 1749, and received his education at Cirenceſter in the ſame county. Having made a conſiderable progreſs in claſſical learning, and ſhowing an early attachment to the ſtudy of phyſic, he was placed under the care of Mr. Ludlow, an eminent ſurgeon at Sodbury, a large market-town between Briſtol and Wotton under Edge. After remaining with this gentleman ſome time, during which he applied with aſſiduity, and made rapid improvement, he repaired to London to complete his medical education, and became a houſe-pupil to the celebrated John Hunter. In this ſituation he continued two years, and availed himſelf with great ſucceſs of the inſtruction of ſo able a maſter. At the expiration of this period he removed to Berkley, where he commenced practice, and met with conſiderable encouragement. In the mean time he ſtill kept up his intimacy with Mr. Hunter by a regular correſpondence; and the frequent mention which Mr. Hunter has made of him in his works is a ſtriking inſtance of the favourable opinion which he entertained of his abilities. An ingenious paper on the natural hiſtory of the cuckow, in a letter addreſſed to Mr. Hunter, was communicated by him to the Royal Society, and was inſerted in the Philoſophical Tranſactions for 1788. Several other papers of his on intricate ſubjects in natural hiſtory were publiſhed about the ſame time. In 1778 he married miſs Catherine Kingſcote of Kingſcote in Glouceſterſhire, by whom he

he has two ſons and a daughter. Of late he has reſided with his family in London during the winter, but the ſummer ſeaſon he general ſpends at Cheltenham or Berkley. For ſome years paſt he has devoted himſelf chiefly to reſearches and obſervations in regard to the vaccine inoculation, one of the moſt important diſcoveries of modern times, as it gives reaſon to hope that the ſmall-pox, ſo fatal to the human race, may at length be totally eradicated. But as this ſubject has been ſufficiently illuſtrated by various publications, and particularly thoſe of Dr. Jenner, Dr. Pearſon, Dr. Woodville and others, to whom the world is much indebted for the introduction and propagation of this practice, it is needleſs here to ſay any thing further reſpecting it. In 1800 Dr. Jenner publiſhed a continuation of Facts and Obſervations relative to the Variolæ Vaccinæ, or Cow-Pock, which was ſoon followed by an Appendix to the Treatiſe on the Cow-Pock. The facts relating to this diſcovery have been ſo fully eſtabliſhed by unqueſtionable evidence and authority, that every friend to mankind ought to uſe his utmoſt endeavours to promote a practice attended with ſuch valuable benefits to the human race. It muſt give pleaſure to every benevolent heart to find that, in conſequence of the prevailing perſuaſion of the uſeful tendency of this practice, thoſe at the head of the naval and military departments of government have lent their ſanction to it, and given orders for the general introduction of it into thoſe branches of the public ſervice; ſo that it is now practiſed with the fulleſt ſucceſs in the naval and military hoſpitals, and in the regiments and ſhips of war upon ſervice; and it can be ſaid, as an additional recommendation in its favour, that it does not prevent thoſe who are under it from doing their duty. Nations even which, in conſequence of their ignorance, have long been under the wretched influence of the moſt childiſh ſuperſtition, and who, on that account, have been hoſtile to many valuable improvements received and eſtablished among more enlightened ſtates, have begun to open their eyes to the advantages of this new practice; and hence it has been adopted in Spain, Ruſſia and Italy, and even made its way into the Ottoman dominions, and among the American Indians. But, notwithſtanding the importance of this diſcovery, like all others that have benefited mankind, it has had violent opponents. The facts alleged were doubted, tales were fabricated to prejudice the impartial, and this laudable undertaking was attacked, and cenſured as a *beaſtly* attempt. Eſſays were publiſhed on both ſides: but a great majority approved of the practice; and it, at length, was found worthy the con-

ſideration of the Imperial Parliament, which, after examining various documents, and hearing the teſtimony of ſeveral profeſſional men of the firſt eminence, acknowledged the value of the diſcovery by voting a reward of 10,000l. to Dr. Jenner.

XLV. *Deſcription of the different Methods of blowing up Rocks under Water. By* A. Baillet, *Inſpector of Mines**.

1ſt, THE operation of blowing up rocks, which the French call *tirage des mines*, is not in general attended with much difficulty, when the hole of the mine is pierced in dry compact ground without any fiſſure or cavity. When the ground is cavernous or hollow, or when water oozes through its pores, it becomes more troubleſome, and requires particular care. When it is neceſſary to blow up rocks at the bottom of the water the difficulties are increaſed. In that caſe the uſual proceſſes muſt be abandoned, and others muſt be reſorted to.

2d, The method of blowing up rocks in the latter caſe is little known, and not much practiſed: it may, however, be of great utility in many caſes, not only in the working of mines, but in the execution of public works of importance. Theſe motives have induced me to give a deſcription of the three principal methods of blowing up mines under water.

The firſt is that uſed in the mines in the northern part of the republic: it is proper to be reſorted to when the depth of the water which covers the ground intended to be blown up is not above 15 or 18 decimetres.

The ſecond has a great reſemblance to the proceſs uſual in mines when the ground ſuffers the water to ooze through it. It is ſimpler and leſs expenſive than the preceding, and appears to me to be very proper for caſes when there are only a few decimetres of water above the ground.

The third is ſuited to great depths of water, ſuch as 4, 5, or 6 metres: it is that employed at Carlſcrona. It is very ingenious, and ſeems hitherto to have been unknown to the French miners.

3d, But, before I begin to deſcribe theſe methods, it may be of ſome uſe to mention here an intereſting memoir, printed in the Journal de Phyſique for the year 1779, on the conſtruction of air-boats proper for facilitating the execution of all ſorts of works under water, without employing pump-

* From the *Journal des Mines*, No. 56.

ing.

ing. C. Coulomb, the author of this memoir, after deſcribing the method of conſtructing the air-boat, ſhows in what manner it is to be uſed. He points out the means by which it may be made to ſink at pleaſure, of placing the workmen under the box, of continually renewing the air, of removing the rubbiſh and laying a foundation of maſon-work at the bottom of deep water. He then calculates the time neceſſary for removing a metre in height from the bank of Quillebœuf, which interrupts the navigation of the Seine; and foreſeeing the caſes in which mattocks or pick-axes would be inſufficient for clearing obſtructions from the bottom of the water, and where the hardneſs of the rock might require the uſe of gun-powder, he propoſes two methods of blowing up rocks under water.

In one, the workman placed under the box bores the rock, and introduces into the bottom of the hole a box of tin plate filled with gun-powder, to which is ſoldered a ſmall tube, alſo of tin plate, which riſes above the water at ebb-tides, and which is ſtopped with ſome greaſy matter, after having been filled with a very weak compoſition to ſerve as a train. The ſea, as it riſes, makes the air-boat float; and when its lower edge has riſen higher than the extremity of the tube it is then removed, and when the ebb-tide uncovers that extremity a perſon goes in a boat and ſets fire to it.

In the other method, which the author propoſes for the Mediterranean, and rivers where the aſſiſtance of the tide cannot be employed, the tube of tin plate which contains the train riſes only 3 decimetres above the rock, but is terminated by a leather pipe covered on the outſide with ſome water-proof ſubſtance, and in the inſide with an incombuſtible varniſh, and ſecured from the preſſure of the water by a ſpiral winding made of wire. Its extremity muſt be carefully cloſed, and a buoy attached to it carries it to the ſurface of the water when the air-boat is afloat.

4th, I ſhall ſay nothing further of theſe methods, which ſuppoſe, as may be ſeen, the aſſiſtance of the air-boat. I only wiſhed to point them out, becauſe they may be uſeful in many caſes, and may, beſides, give riſe to new ideas, and ſerve to modify the three particular methods which are the object of this memoir.

I. *Method of blowing up Rocks at the Depth of 15 or 18 Centimetres under Water.*

5th, This method conſiſts in the following operations;

Firſt, bore the hole at the bottom of the water by the help of borers, and inſtruments of proper length.

Then place in the hole a tube of tin plate closed at the lower extremity. The exterior diameter of this tube is of such a size that, when introduced into the bore, it may fill it; and its length must be such as that it shall rise some centimetres above the surface of the water.

Then send down to the bottom of this tube the cartridge filled with powder; introduce the priming rod, and ram round it clay or plaster according to the usual process, and only to the height corresponding to the summit of the hole.

In the last place, draw the priming rod and introduce the train, and set fire to it with all the necessary precautions, that the workmen may be sheltered from danger at the time of explosion.

Observation.

6th, This method has been often employed with advantage in several mines of the republic: it may serve either for deepening wells, or making other excavations, when the means used for keeping the ground and bottom of wells constantly dry are insufficient.

II. *Method proposed for blowing up Rocks some Decimetres below Water.*

7th, When the ground or rock to be blown up is covered only by some decimetres of water, the miner can see the rock which he bores, and the hole to be loaded, with as much ease as if there were no water, and can work with the same facility. In this case, to save expense, the tube of tin plate may be omitted, and a cartridge of pitched cloth, such as that employed in ground through which the water oozes in every part, may be employed, adapting to it a rod of hollow wood * destined to contain the train that conveys the fire to the powder. The diameter of the aperture of this rod may be only a few millimetres, and its length must exceed the upper level by some centimetres.

8th, If this method be adopted, first construct a cylindric cartridge of cloth or pasteboard, and fill it with gunpowder; insert into it the rod, which must descend to the middle of the length of the cartridge without approaching the interior surface of the wrapper; pinch closely the upper part of the cartridge around the rod, and cover the cartridge and whole rod with pitch or some kind of varnish †. Then send down the cartridge furnished with its rod into the hole of the rock,

* This rod might be made of the elder or honeysuckle.

† A solution of Spanish wax in alcohol is attended with the advantage of drying speedily, and of remaining water-proof for a long time.

and

and drive in ſtrongly two plugs of dry wood to ſerve as wadding. Theſe plugs muſt have a longitudinal groove, that they may glide along the rod and ſuffer the water to eſcape.

Obſervation.

9th, Inſtead of a rod of hollow wood you may employ, with advantage, either a tube of tin plate about four millimetres in diameter, terminating at the lower extremity, which muſt be inſerted in the cartridge in a truncated cone, and an orifice of two millimetres; or a leaden pipe drawn in the manner of wire-drawers, having the ſame dimenſions as the above, and whoſe reſiſtance may be ſufficient, if you take care to introduce into it, while you drive in the wadding, a rod which may exactly fill the interior vacuity.

If you have at hand any kind of compoſition capable of acquiring hardneſs in a little time * at the bottom of the water, you may ſubſtitute for the rod and metallic tubes a flexible tube of cloth done over with pitch or gum. In this caſe, it will be neceſſary to introduce the priming rod into the tube, while you drive in the wadding to prevent its depreſſion. The cloth of the tube, the upper extremity of which is deſtined to riſe above the hole in the rock, muſt be ſufficiently thick and ſtrong that the preſſure of the water, which I ſuppoſe to be ſome centimetres above the ground, may not flatten it, even if the liquid ſhould introduce itſelf between the tube and the compoſition.

III. *Method of blowing up Rocks under Water at any Depth.*

10th, This method, on the firſt view, has a reſemblance to that firſt deſcribed, ſince a tube of tin plate is employed in it; but it differs eſſentially from it in this reſpect, that inſtead of wadding above the charge, according to the uſual method, you employ an inflexible ſhank charged with a weight at its upper extremity, and terminating at the lower in a ſegment of an iron cylinder, which performs the office of a wedge, and is applied exactly upon another ſimilar wedge inverted and reſting on the upper end of the cartridge.

The effect of this diſpoſition, as may be readily conceived, is to force the wedge which adheres to the cartridge to aſcend a little at the time of the exploſion, and to ſqueeze itſelf cloſely againſt the upper wedge ſo as to cloſe the hole in the rock.

11th, The deſcription of this proceſs may be ſeen in the

* A mixture of quicklime and plaſter newly calcined would, perhaps, be of this kind.

twelfth

twelfth volume of the Memoirs of the Academy of Stockholm; I ſhall therefore give a literal tranſlation of it *.

IV. *New Method of blowing up Rocks under Water, by Daniel Thunberg.*

A profile of the rock which has been bored, and into which the charge is introduced, is repreſented Pl. V. fig. 1.

The charge is contained in a tube of tin plate impermeable to water, a vertical ſection of which is repreſented in the ſame figure. The lower extremity of this tube muſt be adjuſted properly to the hole which has been bored in the rock.

The charge conſiſts of a paper cartridge filled with gunpowder, and attached to the iron wedge *b* with a thread ſuch as that uſed for ſewing ſails.

To this firſt wedge *b* is applied another *c*, which adheres to an iron rod that riſes above the tube.

On the plane face of theſe wedges is a groove made with a file which reaches to the powder: this groove is continued throughout the whole length of the tube of tin plate by means of a wooden rod *d*, hollow on the ſide turned towards the iron rod, to which it is made faſt with ſtrong packthread.

Before this rod is attached to the iron one, a match, which proceeds from the upper extremity and communicates with the interior of the cartridge, is placed in the groove.

e is a train applied to the end of the match.

B, C, are two rafts which enable the workmen to bore the rock and blow it up.

D is a weight which prevents the iron from being repelled too far when the exploſion takes place.

E F G H I are different pieces neceſſary for charging. E is the cartridge furniſhed with its wedge, ſeen ſideways; F the wedge ſeen in front; G the wooden rule and its groove; H the upper wedge and its iron rod; I the tube of tin plate.

When the rock has been bored according to the uſual method by employing a borer pretty ſtrong and of ſuch a length as the depth of the water may require, introduce into it the tube into which the charge has been put; then apply the train *e*, and, having placed the weight D above the rod, ſet fire to it. The exploſion will immediately take place: the wedge *b* would be expelled but for the wedge *c*, which cannot give way; and the two wedges being thus united confine the charge, the effect of which will never fail, as has been proved by experience.

* Details reſpecting this proceſs may be found alſo in a large work entitled *Deſcription des Travaux executés à Carlſcrona, par* Daniel Thunberg.

Four

Four feet of the tube and the lower wedge are in general loſt; but the upper wedge may be employed for new charges, becauſe it is never damaged.

Obſervation.

12th, This method, the ſucceſs of which is proved, deſerves, no doubt, to be known by all thoſe engaged in great undertakings, and who have frequent occaſion to apply it *. It is, perhaps, ſuſceptible of being modified; and it appears to me that, without employing the impermeable tube, a varniſhed cartridge might be uſed, with a flexible tube proceeding from it, lodged in the groove between the two wedges, and then riſing above the water.

Fire alſo might be conveyed to the powder below the water by means of a ſtrong diſcharge of electricity; but little can be expected from this method in the hands of workmen.

In the laſt place, the lower wedge might be made of hard and very dry wood.

13th, But in whatever manner this method may be employed it will not require great expenſe, and it may be uſed with great advantage for deepening ports, rendering certain harbours more convenient and ſafe, and for freeing rivers and ſtreams from thoſe rocks which obſtruct their courſe and impede the navigation of them.

XLVI. *Account of a North-Eaſt Storm, or Memorandums towards a Theory of the Winds in the Region between the Gulf-Stream and the Great Range of Mountains* †.

ON the Atlantic coaſt of America north-eaſt ſtorms begin in the ſouth-weſt, and proceed thence to windward at the rate ſometimes of about one hundred miles an hour. It has been remarked long ago by Dr. Franklin, that ſtorms from the north-eaſt, on the eaſtern ſide of this continent, begin in the oppoſite point, or to leeward. Whether this rule univerſally obtains may perhaps as yet admit of ſome doubt:

* M. Daniel Thunberg employed the ſame means to raiſe large blocks of ſtone from the bottom of the water. For this purpoſe a hole is bored in the block with a miner's borer to the depth of twenty or twenty-five centimetres. Two wedges are introduced into it, forming by their junction a cylinder ſo as to fill the hole. Several blows are then ſtruck on the iron bar which adheres to the upper wedge: the two wedges are then cloſely ſqueezed together, and the block is raiſed out of the water by means of a windlaſs and a cord attached to a ring fixed in the lower wedge.

† Communicated by Dr. Mitchill.

but

but during the uncommonly mild winter of 1801—2, there was a ſtrong confirmation of it.

On the 21ſt, 22d, and 23d of February 1802, there was one of the moſt remarkable and long-continued ſnow-ſtorms that had been known for twenty years. It raged with extreme violence on the land, and was the cauſe of ſeveral ſhipwrecks along the ſea-coaſt. Many lives and much property were loſt. The movements in the atmoſphere were felt firſt to the ſouthward, and gradually progreſſed northward, ſo as to be ſenſible there; but not until after ſome hours.

The facts were collected by Dr. Mitchill, at Waſhington, the ſeat of the national government, during the ſeſſion of congreſs, when they could be aſcertained with the greateſt expedition, correctneſs, and care, and are as follow:

After a fine, warm, and clear morning, the air toward evening grew cloudy, and it became rainy and ſtormy. The time of its commencement near the capitol, on the banks of the Potomack, as obſerved by general Smith, was about half an hour paſt five in the afternoon; and before eight the rain was exceſſive, and the wind boiſterous. Here the weather did not become cold enough for ſnow until towards morning.

The city of New-York, which is ſituated rather more than 240 miles to the north-eaſt, did not feel this commotion of the atmoſphere until about eleven. Then the city watchmen obſerved that the weather was changed from clear to cloudy, and that ſnow began to fall; and at twelve Mrs. Mitchill, who opened a window and looked out, obſerved that the ground was already white with ſnow. The tempeſt was brewing, and, properly ſpeaking, was formed at two.

That night Mr. Humphrey Wood was on board a ſloop bound from Newport (R. I.) to New-York. The tempeſt drove the veſſel aſhore before morning on Mount Miſery Neck, upon Long Iſland. They ſailed from Fiſher's Iſland, where they had been waiting for a fair wind, at ten o'clock at night, with a wind at eaſt-ſouth-eaſt, and warm and pleaſant weather. But by midnight it hauled eaſt-north-eaſt, and blew a gale, with ſnow. Fiſher's Iſland may be computed to be about 140 miles eaſt-north-eaſt of New-York.

Mr. Webſter obſerved ſome of the phænomena of this change of weather, in its beginning, at New-Haven. This place is 89 miles from New-York, or 331 from Waſhington. Here the weather was clear in the early part of the evening, but was overcaſt by nine. The ſtormy commotion of the atmoſphere ſeems to have begun about twelve. At Boſton it was rather more than an hour later.

Mr. Blair, an officer who was on board one of three ſhips

from Salem, in Maſſachuſetts, that were loſt on Cape Cod during the ſtorm, related, after his eſcape, that the weather, on the day of their ſailing, Sunday, Feb. 21, was remarkably fine and favourable. At ſun-ſet they were about four leagues from Cape Ann light-houſe, with a light breeze from ſouth-eaſt. After midnight the weather grew very threatening; and at half paſt two in the morning of the 22d the wind veered to the north-eaſt, and it ſnowed ſo faſt that the ſhips could hardly diſcern each other. The ſhipwrecks during this ſtorm were numerous and dreadful. Many perſons were frozen to death. Salem is diſtant from Waſhington 499 miles, or 257 from New-York; ſo that this latter place is about midway between the two places.

At Portland, in Maine, diſtant 603 miles from Waſhington, the ſnow began between daylight and ſunriſe. It was obſerved by young Mr. Vaughan, who was travelling on the morning of the 22d. At 8 A.M. the wind blew violently.

The ſtorm began ſtill later at Hallowell, on the Kennebeck river. This place is 683 miles from Waſhington. There the ſun roſe clear on the morning of the 22d. The air became cloudy in about a quarter of an hour. The ſnow began about eleven, and the ſtorm had become furious within two hours after. Profeſſor Waterhouſe and Benjamin Vaughan, eſq. have particularly attended to theſe curious meteorological facts.

At Poughkeepſie, 82 miles north of New-York, and ſituated beyond the firſt range of mountains, the ſtorm began about four o'clock on the morning of the 22d. And at Albany, 165 miles north of New-York, it did not begin until a little before day-break on the morning of the 22d.

At Providence (R.I.) Dr. Wheaton obſerved the evening of the 21ſt to be clear and pleaſant. The watchmen informed him "the weather changed before 12 o'clock, and continued cloudy, with variable winds, until the violence of the ſtorm began, which was at half paſt three on the morning of the 22d." Providence is 439 miles from Waſhington.

Accounts from Charleſton (S. C.) ſtate that it began there on the 21ſt, between two and three o'clock in the afternoon. The diſtance of Charleſton from Waſhington is 550 miles. By the newſpapers it appears to have been felt in the Bahama iſlands.

It will be found, on calculation, that between Charleſton and Cape Ann, along the coaſt, this ſtormy movement proceeded to windward at the rate of nearly one hundred miles an hour: for, as it began at Charleſton, ſay at three o'clock, at New-York at eleven, and off Cape Ann at two the next morning,

morning, there is a difference of eight hours between Charleston and New-York, and of three hours between the latter city and Salem, making in the whole eleven hours. Now, computing the distance from Charleston to New-York at about 800 miles, and from New-York to Cape Ann more than 250, there will be a sea-coast of almost 1100 miles swept over by this storm in somewhat more than eleven hours. But this computation applies only to the sea-coast; for, if we take any given point, as the city of New-York for example, and instead of north-east reckon due north, it will be found that the progress is considerably slower: for it took all the time between eleven at night and day-break next morning to reach Albany, only 165 miles distant in that direction.

Now, these remarks explain some meteorological facts, which, though of common observation, have hitherto seemed paradoxical or unaccountable: for mariners know that, to form a good judgment of wind and weather, they must keep a look-out for clouds and changes of atmosphere to leeward. In New-York, the rain or snow which accompanies a north-east storm can be seen by labourers along the docks and wharves in the south-west at Staten island, ten or eleven miles distant, for some time before it begins in the city, so as frequently to break off work, and put away their tools. And it is confirmed by long observation among the farmers in that vicinity, that snow-banks, as they term them, are to be seen in the south-west many hours before the atmosphere where the observers are is clouded in the smallest degree, or any current of air perceptible. They remark further, that a judgment can be formed of the weather by noting whether the gathered clouds lowering in the distant horizon are visible to the northward or southward of the setting sun. If at sun-set they are to the south of the sun, they predict a north-east storm, with snow; if to the north, a south-east storm with sleet or rain.

XLVII. *Note on the Memoir of* Clement *and* Desorme, *entitled Experiments on Charcoal**. *By* C. Berthollet †.

C. Clement and Desorme remark very properly, that all gases contain, at the same temperature, the same quantity of hygrometric water. This is shown by the observations of Saussure and Deluc. Volta assured himself of it

* See the last two numbers of The Philosophical Magazine.

† From *Annales de Chimie*.

by

by direct experiments, which he made known when at Paris, and which are already old; and Prieſtley announced, that all gaſes diſſolved the ſame quantity of ethereal gas, except a ſmall difference exhibited by the carbonic acid, which may be eaſily accounted for.

If the experiments deſcribed by Clement and Deſorme had been exact, they would have found in a cubic foot of ſaturated atmoſpheric air, at nearly 7 degrees of the thermometer*, the ſame quantity which they obtained at 12 or 13 degrees of the thermometer.

The elaſtic vapour of water has a ſpecific gravity, which is to that of air, at the ſame degree of compreſſion and temperature, as 10 to 14; but, beſides this, there is, in ſome gaſeous ſubſtances, water combined and more condenſed, which has no influence on hygrometric phænomena; a diſtinction which I indicated in the *Annales de Chimie*, by announcing that I ſhould treat this object in another place, and with the neceſſary details.

It is this combined water which is more or leſs wanting in natural carbonate of barytes, as has been very properly remarked long ago by Withering: hence it happens that the acid of this carbonate cannot be diſengaged by heat, though it may be diſengaged from artificial carbonate, which has retained enough of water to give ſome of it to the carbonic acid; but, by employing very dilute nitric acid, the carbonic acid is diſengaged from the former as well as the latter, as has been alſo remarked by Withering.

Prieſtley has ſhown, that, by making the ſteam of water to paſs upon native carbonate, carbonic acid is eaſily obtained from it: he juſtly aſcribes the effect to the part which the carbonic acid ought to take up: he made experiments to determine the quantity of it, and though the means ſeem exact, his reſults appear to me exaggerated.

It is only by this water that we can explain the quantity of hydrogen gas which is obtained by ſubjecting carbonic acid to the action of the electric ſpark, as done by Dr. Prieſtley, Van Marum, Monge and Henry, without decompoſing the carbonic acid.

It is not the hygrometric water which experiences this decompoſition, or it forms only a very ſmall part of it; for the quantity of hydrogen gas is too conſiderable, and Henry made the experiment with very dry carbonic acid.

C. Clement and Deſorme, who pronounce with ſo much confidence that I am wrong, and who did not deign to wait

* We ſuppoſe Reaumur's thermometer is meant.——Edit.

for the publication of my labour on charcoal and carbonated hydrogen gas, that they might refute the reasons on which I have founded my opinion, pretend that 48 parts of oxygen can diffolve 52 of charcoal, a folid fubftance, the fpecific gravity of which is conficderable, and yet the combination refulting from it, their gafeous oxide of carbon, has a fpecific lightnefs greater even than that of oxygen gas.

I could wifh they would point out fome other compound gas in which a fpecific levity greater than that of the lighteft of its elements can be obferved. Nitrous gas is fpecifically heavier than azotic gas; fulphurous gas, and oxygenated muriatic gas, heavier than oxygen gas; the vapour of water is heavier than hydrogen; ammoniacal gas, carbonated, fulphurated, and phofphurated hydrogen are heavier than hydrogen gas.

Here 48 parts of oxygen diffolve, at firft, 17 of charcoal, to form carbonic acid, which is heavier than oxygen gas, fince they diffolved 35 parts more of the fame charcoal, which was folid; and the combination has a fpecific levity greater not only than that of carbonic acid, but even than oxygen gas.

The phænomenon becomes more ftriking when a fimilar gas is fubjected to the action of the electric fpark; for Auftin and Henry obferved, in making the experiment on that extracted from the acetite of pot-afh, that its volume was doubled *.

Confiderations on the action of the affinity which produces here a phænomenon fo diftinct from others, and fo contrary to the ideas which we have of that action †, would not be unworthy of their refearch. Thefe general confiderations ought not always to be rejected as deceitful analogies: in my opinion, they ought much rather to ferve as a guide to chemifts, and to inform them in particular of their miftakes.

C. Clement and Deforme unite to their ftrictures fome intereffing experiments on a new combination of fulphur; they appear to me to have proved that it contains charcoal, and that it is neither fulphurated hydrogen nor hydrogenated

* In the *Annales de Chimie*, No. 124, I mentioned this gas as one of thofe that contain water combined; but new obfervations have proved to me, that the decompofition of water could have only a very fmall fhare in the dilatation it experiences.

† Affinity, or chemical attraction, fays Guyton, proceeds from the reciprocal tendency of all the moleculæ to a perfect contact. Nature has not force to feparate, to remove to a diftance; it has only force to bring together and unite.——*Encyclopædia*, word Affinity.

fulphuret;

ſulphuret; but if I might be allowed a conjecture on a ſubject with which I am not yet acquainted, it appears that we cannot refuſe to acknowledge in it the exiſtence of hydrogen. In my opinion, its great volatility cannot reſult from two ſubſtances, ſuch as charcoal and ſulphur, which not only are much more fixed, but which contain no other ſubſtances diſpoſed to aſſume the elaſtic ſtate.

I ſhall here remark, by the bye, that they ſay, that by heating in a retort a mixture of ſulphur and charcoal, nothing is obtained but a little gas, of a bad odour, inſoluble in water; and that Kirwan, on the contrary, ſays, ſpeaking of hepatic air, that having treated with fire, ſulphur and charcoal which he had before kept a long time in a red heat, he obtained hydrogen gas in great abundance.

It is not exact to ſay, "that an experiment proved to them, that 100 parts of carbonic acid are compoſed nearly of 28 parts of charcoal and 72 of oxygen;"—a reſult given by Lavoiſier. This great man, in the concluſion of his memoir, in which the reſults preſented differences, expreſſes himſelf as follows:—"The experiments made ſince incline me to believe, that the proportions in charcoal are forced; and I am of opinion, that the quantity of carbon contained in a quintal of carbonic acid does not exceed 24 pounds, and that of oxygen is at leaſt 76 pounds."

His opinion would be very different from that of C. Clement and Deſormes, if they ſhould ſtill prove that charcoal is an oxide which contains already 32 per cent. of oxygen, though it is more inflammable than the baſe to which it is indebted for its inflammability, carbon, or the diamond.

XLVIII. *Memoir on the tenth Planet diſcovered by Dr.* Olbers. *Read in the Public Sitting of the French National Inſtitute, July 5th, by* Jerome Lalande.

When we announced, in the laſt public ſitting, the diſcovery of a planet by M. Piazzi of Palermo, we were far from thinking that, in three months, we ſhould have to make known a diſcovery of the ſame kind. It was alſo by a fortunate accident that this tenth planet was diſcovered; but accident could favour none but an intelligent and indefatigable aſtronomer.

On the 28th of March, at nine in the evening, Dr. Olbers of Bremen was obſerving Piazzi's planet, with which aſtronomers have been engaged for a year. He was examin-

ing with his telescope all the small stars in the Virgin's wing, to ascertain their positions, that he might be better able to establish the place of the planet, and had come to the 20th star of the Virgin, near which he had observed the planet in the month of January. He was surprised to see near this star, which is of the 6th magnitude, another smaller of the 7th magnitude. He was very certain that it had not been there at the time of his first observations: he therefore hastened to determine its position; and, having continued to view it for two hours, he perceived that it had changed its place in the course of that interval. The two following nights afforded him the means of being certain of its motion, which was 10′ minutes per day. On the 28th of March, at $9^h\ 25'$ mean time, at Bremen, it had $184°\ 56'$ right ascension, and $11°\ 33'$ north declination.

Astronomers have been accustomed to consider as comets, all stars that have motion. This was the case with the planets of Herschel and Piazzi at the time when they were discovered. That of Dr. Olbers had no more resemblance to a comet than the rest. With an achromatic telescope, the magnifying power of which was 180, it could not be distinguished from stars of the 7th magnitude. It was better defined than the planet of Piazzi; and, with a telescope of 13 feet, which magnified 288 times, it seemed to have a diameter of 4 seconds: but this was an effect of irradiation, or of the dispersion of the rays of light, which always makes the diameters appear too large; for the satellites of Jupiter appear much larger than the new planets, and yet we know that their apparent diameter is not a second.

Dr. Maskelyne, by means of diaphragms placed before the object-glass of his telescope, ascertained that the light of Piazzi's planet is stronger by one half than that of the new planet.

Dr. Olbers having observed the new star for four days, he sent notice to different astronomers; and on the 10th of April, C. Burckhardt, when he received his letter, went immediately to the military school to search for it, and next day sent his observation to the Institute.

He began to calculate its orbit, trying first a circle, and then the parabola known to be that of comets; but, at the end of three days, his elements were found to err 30 seconds. He tried also ellipses of different dimensions.

On the 15th of May we were informed, by a letter from baron von Zach, the celebrated astronomer of Gotha, that Dr. Gauss, an astronomer of Brunswick, had found an ellipsis which corresponded to the first observations. On the

22d we received the details. He found the revolution to be four years seven months, and the inclination 35°. This great inclination seemed to remove it from the order of planets, and some astronomers called it a comet; but its proximity, and continual appearance, will not allow of its being placed among the number of those stars of which we often lose sight for so long a time, and which go to enormous distances.

C. Burckhardt, on his part, made similar researches; he made several trials with ellipses very much elongated, which gave him a result very near that of Dr. Gauss.

On finding that this planet, like that of Piazzi, was between Mars and Jupiter, and that its motion must be affected by the attraction of Jupiter, C. Burckhardt undertook to calculate these perturbations. The calculation is long and difficult, but it is indispensably necessary to obtain the orbit with more exactness.

At last, on the 4th of June, he finished these laborious calculations, and found the following elements:

Distance 2.791, or 95,890,000.

Revolution, 4 years, 8 months, and 3 days.

Eccentricity, 0.2463; equation of the orbit, 28° 25′.

Epoch of 1802, 4 23° 50′; aphelion, 10 2° 3′; node, 5° 22° 28′; inclination, 34° 50′ 40″.

These elements corresponded to five observations of the 4th, 16th, and 27th of April, and the 7th and 20th of March; the last two made by C. Burckhardt, and Lalande the nephew, who, as well as C. Mechain, Messier and Delambre, continued to observe it as long as it could be seen in the meridian, because such observations are the surest. After the 21st of May, other instruments and other stars were necessary; but it still passed through some included among the 15000 stars which we have published. On the 15th of June these elements corresponded, within a few seconds, with the observations of Mechain and Messier; which confirms the exactness of the elements found by C. Burckhardt, and assures us, that the motion of the new planet is already known. Baron von Zach has published a great many observations respecting it in his Journal.

C. Cabrol de Murol has calculated for us an ephemeris, which gives the situation of this planet to the 21st of October, on which day it will have 227° 7′ of right ascension, and 6° 8′ of declination. It will then set at 7^h 51′: there is therefore reason to think that it may be still observed. It will be above Libra near the Serpent, after passing the legs of the Cow-herd. He finds that, in 1806, it will have $33\frac{1}{2}$°

of south declination, and that it will then be difficult to see it at Paris: but C. Vidal, who has already observed it this year, will then be better able than we to follow it.

Its greatest northern declination will not exceed $26\frac{1}{2}$ degrees, a term at which it will be a year hence. It will be easier to be seen, but its distance will be double, and its light four times less than the present year. In the month of March 1804, it will be at three times the distance; its light will be nine times less, and, in all probability, it will be difficult to observe it.

As the orbit of this new planet intersects that of Piazzi, I was curious to know whether the two planets might not meet; but I found that, when they are in the same plane, there will be an interval of about 19 millions of leagues between them.

The planet of Dr. Olbers is very small. If we suppose its apparent diameter to be half a second, find that its real diameter cannot be more than 100 leagues. Dr. Herschel, in a paper which he read before the Royal Society on the 7th of May, makes it to be four times less. He says, that on the 22d of April Piazzi's planet was only 22 hundredths of a second, and that of Olbers 13 hundredths; but it appears to me, that we have no means of determining, with certainty, quantities so small.

Dr. Olbers calls his new planet, Pallas; but, as I see no sufficient motive for this fabulous denomination, I prefer giving it the name of the person to whom we are indebted for this valuable discovery.

Dr. Olbers distinguished himself in 1797 by an excellent treatise on comets, and was worthy of the good fortune with which his labours have been crowned.

(For a further account of Dr. Olbers, see the last number of the Philosophical Magazine, where an engraving of him is given.)

XLIX. *Notices respecting New Books.*

An Examination of the Report of the Committee of the House of Commons on the Claims of Remuneration for the Vaccine Pock Inoculation, containing a Statement of the principal historical Facts of the Vaccina. By GEORGE PEARSON, *M. D. F. R. S. Physician to the Vaccine Pock Institution, Senior Physician to St. George's Hospital, Honorary Member of the Board of Agriculture, &c.* Johnson, 8vo. 1802.

THE inoculation of the cow-pock having always appeared to us to be interesting, not only on account of the improvement of the practice of medicine from it, but also as a very curious fact in natural history, we have noticed several publications, and received many papers and notices concerning it. It is not our design to give a complete analysis, or even copious extracts; but the present work demands an early account, as, no doubt, many of our readers will be eager to know what is the object of the present examination, which the author states to be—

"1. In order to submit to the judgment of the public, whether or no more honourable and just grounds might not have been asserted for the remuneration of the petitioner.

"2. In order to offer evidence for the manifestation of several truths, and for the exposition, perhaps, of some errors and mistakes; and

"3. With the view of obtaining the opinion of the public, whether or no any credit be due to others for the discovery of facts; the detection of ill-grounded assertions; and for labour, expenditure of time, and other sacrifices, in introducing and maintaining the vaccine inoculation."

The author, in the very first page, sets out with declaring to the public that Dr. Jenner is the discoverer of the vaccine inoculation, and in this point of view he considers him as entitled to the remuneration by a prior right to every other person; but in the course of the work he brings out a great variety of facts in evidence, to show that neither the necessary facts for the present practice were discovered by Dr. Jenner, nor were the facts which he published even established by a sufficient number of experiments. The author brings out a great number of extracts from publications, to show that he had no small share in investigating the vaccine inoculation practice; but that the petitioner claims, or rather the committee in their report affirm, the whole practice to have been established by him. To show the contrary,

the author exhibits the amount of Dr. Jenner's experience, the value of which he allows to be great, and that it was the direct occaſion of all that has been done ſince his publication.

1ſt, He ſtates that the whole amount of Dr. Jenner's experience was but ſeven or eight caſes of inoculation of the cow-pock.

2d, That he gave no deſcription of the cow-pock; ſo that, after the practice was begun, miſtakes on this account were made, which were rectified by the characters of the eruption aſcertained by the author and Dr. Woodville.

3d, That they brought out the evidence of ſeveral hundred caſes in two or three months time, which before were, as above aſſerted, only ſeven or eight.

4th, That Dr. Jenner in giving plates of the cow-pock did not mention what day after inoculation, which made them of little uſe, and miſled by affirming that the inoculated eruption was ſo like the ſmall-pox that the moſt experienced inoculator could not diſtinguiſh them from the ſmall-pox. To ſhow the inexperience of Dr. Jenner, the author gives a plate of the two inoculated diſeaſes, from which it appears, Dr. Pearſon ſays, incredible, on account of the difference, how Dr. Jenner could ever have ſpoken of ſuch a reſemblance, if his experience had not been confined to a few caſes?

5th, That Dr. Jenner's experience muſt have been very limited, from his recommendation of applications of a cauſtic nature, found to be ſubſequently unrequired—from his deriving the cow-pock from the greaſe of horſes—from his affirming that a perſon could, again and again, have the vaccine diſeaſe; and even after the ſmall pox—from expecting ſo much inflammation that the ſafety to infants was dreaded—from his not knowing that very commonly there is no ſenſible conſtitutional diſeaſe; and yet not deſcribing the cow-pock to know when it really takes place, the practice was not underſtood, and miſtakes were committed which have been ſet right by other perſons. Partly from theſe errors diſguſting the public, and from the deficiencies not leaving a foundation to practiſe upon, Dr. Jenner's claims to ample and excluſive remuneration are rejected by this author, who yet conſiders him as the origin of all the benefits of the new inoculation, and very happily quotes two verſes from Ovid to ſhow that the power now in our hands of extinguiſhing the ſmall-pox is from Dr. Jenner.

Jam labor in fine eſt. Obſtantia fata removi,
Altaque, poſſe capi faciendo, Pergama cepit.

The

The author ſcrutiniſes the ſeveral claims of the petitioner, and endeavours to ſhow that thoſe given to the houſe of commons, as found valid by the committee, are not true according to hiſtory. But, ſays he, a very juſt and dignified ground might have been taken, equally favourable for remuneration, as follows: "That the petitioner had propoſed a new kind of inoculation, and actually furniſhed ſome inſtances of the ſucceſs of it; founded upon facts: of which ſome were brought to light and uſe, which heretofore had been only locally known to a very few perſons; and, that in conſequence of conſiderable ſubſequent inveſtigations, by the author and others, ſuch a body of evidence had been obtained, and ſuch further facts had been diſcovered, as demonſtrated the advantages of the new practice."—p. 165.

Although it appears, according to the evidences, that inoculation was practiſed even from human ſubject to human ſubject before Dr Jenner, yet the author neither conſiders Dr. Jenner nor the public as under any obligations to them, and that ſuch caſes are proper to be recorded in hiſtory, but ought not to affect the remuneration. How far this reaſoning will be allowed to be convincing, we are in doubt.

The author appeals to the public, whether or no he has not proved by evidence that excluſive claims of credit were not due to Dr. Jenner, but that he himſelf and Dr. Woodville, although they aſked for no pecuniary reward, were entitled to the conſideration of having principally eſtabliſhed the practice.

In this Examination, moſt indeed all the valuable facts of the vaccine diſeaſe come under review: in particular, full evidence is delivered concerning the effects of matter according to the age of the pock; the ſubject of ſpurious cow-pock is fully explained; the propriety of local applications; the characters of the cow-pock; the coincidence of the cow-pock with the ſmall-pox, and other facts are explained very fully.

Although the author diſclaims any deſign of ſetting aſide the petitioner's claim to remuneration, he fully proves vaccine inoculation to have been carried on to a great length by others: among theſe is the experience of the late Mr. Naſh, in the Weſt of England, whoſe manuſcripts ſhow that he was prepared to write on the cow-pock inoculation as far ſuperior to the ſmall-pox—1. Not being infectious; 2. Not being attended by eruptions; 3. Being a certain ſecurity againſt the ſmall-pox; 4. Gives caſes of inoculation of cow-pock; 5. Cicatrix after cow-pock inoculation is larger than after ſmall-pox; 6. Perſons who cannot take the ſmall-pox cannot

cannot take the cow-pock; 7. He is to be the firſt writer on the cow-pock, as Dr. Heberden was on the chicken-pock; 8. Differs from ſmall-pox in affecting brute animals; 9. Deſcribes the cow-pock on cows; 10. Cows can take the cow-pock but once; 11. Does not yet know whether a perſon who has had the ſmall-pox can take the cow-pock; 12. In thoſe who have had the cow-pock, on inoculation for the ſmall-pox, there is more inflammation than in thoſe who have not had the diſeaſe. Mr. Naſh wrote his laſt obſervations in 1781. Dr. Jenner's firſt experiment of inoculation, as ſtated from his own book, was in May 1796, and the remaining ſeven caſes in 1798. The author was aſked by the committee whether he thought Dr. Jenner got his information from any preceding inoculator, and he anſwered (p. 36.) "That he imagined they were independent of each other."

It appears that Dr. Pearſon, having had no credit allowed by the committee of the houſe of commons, ſubmits his evidences to the public, to determine in what light he is to be conſidered, as well as Dr. Woodwille, by poſterity.

We are happy to announce that the *Journal des Mines*, the editors of which are C. Brochant, Haüy, A. Baillot, I. L. Tremery, N. L. Vauquelin, and Collet Deſcoſtils, is ſtill carried on upon the ſame liberal and extenſive plan. The editors are all men diſtinguiſhed by their talents and attachment to the ſciences; and the work, of which ſixty-eight numbers are already publiſhed, contains a variety of uſeful and intereſting papers on mineralogy, and every thing that relates to mines and the art of mining in general. Such ſubjects as require it are illuſtrated by plates.

L. *Proceedings of Learned Societies.*

ROYAL SOCIETY OF LONDON.

THE reading of Mr. Chenevix's paper on the chemical analyſis of corundum was finiſhed on the 27th of May.

On the 3d of June a deſcription of the anatomy of the ornithorhynchus hyſtrix, by Everard Home, eſq. F.R.S. was laid before the Society. This animal is a native of New South Wales, and ſeveral ſpecimens have been brought over in ſpirits: its length is about 17 inches; it is covered with hair and with quills. Its bill ſomewhat reſembles that of the ornithorhynchus, but wants the lateral lips. Its teeth are horny,

horny, and confined to the tongue and the palate: the hind legs are furniſhed with a ſpur. The ſtomach has a number of horny papillæ near the pylorus: it is much larger than that of the ornithorhynchus paradoxus: the animal appears to ſwallow a conſiderable quantity of ſand with its food. The ſecond branch of the fifth pair of nerves is extremely ſmall, ſo that this ſpecies has probably no peculiar ſenſe of feeling on its bill: that of ſmell appears to compenſate the deficiency. The ſmall bones of the ear are only two, correſponding to the malleus and ſtapes; the diviſions of the cochlea are cartilaginous. The contents of the pelvis agree with thoſe of the ornithorhynchus, in greatly reſembling the claſs of birds. Mr. Home has examined ſeveral other ſpecies of manis and myrmecophaga, but finds that they all are furniſhed with mammæ. The peculiar characters of the genus ornithorhynchus appear to be the ſpur on the hind legs, the abſence of nipples, the ſmooth beak, and the horny teeth. From all theſe conſiderations, Mr. Home infers that the genus forms a connecting link between the mammalia, aves, and amphibia.

This animal was deſcribed before, by Dr. Shaw, under the name *myrmecophaga aculeata*; but, from the abſence of the mammæ, and its greater internal reſemblance to the ornithorhynchus, Mr. Home places it in the ſame genus.

On the 17th an analyſis of a pulmonary calculus, by P. Crampton, eſq. was read.

Mr. Crampton found in 100 parts of this calculus, 45 of lime, 37 of carbonic acid, and 18 of animal matter and water; this was probably albumen, being coagulable in acids. He thinks it probable that this ſpecimen may have been of a different nature from thoſe which are deſcribed by Fourcroy, and which have been ſuppoſed to contain phoſphate of lime. Mr. Crampton thinks it eaſier to underſtand how phoſphate of lime might have been ſeparated from the blood than carbonate; but he conceives that even this may be depoſited in the lungs by a morbid proceſs, ſimilar to the healthy one by which it is ſecreted to form a conſiderable part of the bones.

The ſame evening a letter from Mr. Carliſle to the preſident was read, containing a deſcription of two kinds of eyes obſerved in the gryllus gryllotalpa, with other circumſtances reſpecting the ſtructure and natural hiſtory of that animal.

On the 24th of June a method of examining refractive and diſperſive powers by priſmatic reflection, by Dr. Wollaſton, F. R. S. was read.

It was ſuggeſted to the author by a conſideration of the priſmatic

prismatic speculum employed by Sir Isaac Newton in his reflecting telescope. The angle at which the total reflection of light of any kind first takes place at the surface of a rarer medium depends on the comparative density of the two mediums in contact, and hence the measurement of this angle readily furnishes a determination of the ratio of refraction at the common surface for the kind of light observed. Thus by means of a triangular prism, a drop of each of two or more fluids being placed side by side on the under surface, it may easily be found, by inclining the prism more and more, which of the dark spots first disappears, and it follows that the respective fluid has the weakest refractive power. But when a solid is examined, it must in general be united by the interposition of some fluid of a higher refractive density, otherwise the contact will be too imperfect; and it is easily shown that this interposition does not affect the ultimate result. But for determining at once the numerical ratio of the sines, Dr. Wollaston has invented an apparatus where, by means of a rectangular prism of flint glass, the index of refraction of each substance is read off at once by a vernier, the three sides of a moveable triangle performing the operations of reduction of the ratios in a very compendious manner. In this method it is obviously unnecessary that the substances to be examined should be of any determinate form; and it is as easy to ascertain the refractive density of the most opaque as of the most transparent bodies, provided they be less refractive than the prism employed. It may also serve as a chemical test, for example in essential oils, which when adulterated are generally rendered less refractive; and a very minute quantity is sufficient for the experiment. Where the medium is of variable density, this is almost the only mode in which its refractive power can be ascertained; hence it is of singular utility in examining the refraction of the crystalline lens. (Philosophical Transactions, 1801, p. 41.) A copious table of the refractive powers of various substances is here inserted. The dispersive powers of different substances are inferred from similar observations upon the fringes which usually accompany, or rather constitute, the boundary of reflection: the author observes that they are sometimes wanting, or even reversed, when the dispersion is equal at different angles of deviation, or when it is greater even with a less deviation, as when oil of sassafras is applied to a prism of flint glass, as well as in many cases of spars with fluids. Solutions of metallic salts in general are found to be very highly dispersive: by weakening the solution till the line of separation became colourless, and then noting the refractive density, Dr. Wollaston has

been

been able to compare the diſperſive powers of ſeveral ſuch ſubſtances with that of plate glaſs. He has alſo arranged a number of ſubſtances in a table in the order of their diſperſive powers, at a given deviation; an order materially different from that of their refractive denſity. A very important obſervation concludes this part of the eſſay. Dr. Wollaſton obſerves, that, by looking through a priſm at a diſtant crevice in a window-ſhutter, the diviſion of the ſpectrum may be ſeen more diſtinctly than by any other method; and that the colours are then only four, red, yelloviſh green, blue, and violet, in the linear proportions of the numbers 16, 23, 36, 25; and that theſe proportions will be the ſame whatever refractive ſubſtance be employed, provided that the inclination of the priſm remain unchanged. In the light of the lower part of a candle, the ſpectrum is diſtinguiſhed by dark ſpaces into five diſtinct portions.

Another communication from Dr. Wollaſton, on the oblique refraction of Iceland cryſtal, was alſo read the ſame evening.

It contains a confirmation of the experiments of Huygens on this ſubſtance, with additional evidence, deduced from the ſuperiority of Dr. Wollaſton's mode of examining the powers of refraction. He obſerves, that Dr. Young has already applied the Huygenian theory with conſiderable ſucceſs to the explanation of ſeveral other optical phænomena, and that it appears to be ſtrongly ſupported by ſuch a coincidence of the calculations deduced from it, with the reſults of theſe experiments, as could ſcarcely have happened to a falſe theory.

On the 1ſt of July was read a paper, by Dr. Young, F.R.S. giving an account of ſome caſes of the production of colours not hitherto deſcribed.

A paper on the compoſition of emery, by Smithſon Tennant, Eſq. F. R. S. was alſo read.

Mr. Tennant finds that emery is diſſolved with ſome difficulty in a ſtrong heat by carbonate of ſoda, and, after the ſubſidence of a little iron, the earth contained in the ſolution is almoſt purely argillaceous. This reſult is exactly ſimilar to Mr Klaproth's analyſis of diamond ſpar or corundum. From 100 parts Mr. Tennant procured 80 of argil, 3 of ſilex, and 4 of iron, with an undiſſolved reſiduum of 3 parts, and a loſs of 10. great care having been taken to ſeparate the parts attracted by the magnet: ſome portions however contained almoſt one third of iron. The hardneſs of emery and diamond ſpar appears to be equal. The emery uſed in England is brought principally from the iſland of Naxos; it is imported

imported in the form of angular blocks, incruſted with iron ore, with pyrites, and mica; ſubſtances which uſually accompany the corundum from China.

A catalogue of 500 new nebulæ, nebulous ſtars, planetary nebulæ, and cluſters of ſtars, was laid before the Society by William Herſchel, LL.D. F.R.S.; and the preliminary remarks on the conſtruction of the heavens were alſo read.

Dr. Herſchel takes a very enlarged view of the ſidereal bodies compoſing the univerſe, as far as we can conjecture their nature; and enumerates a great diverſity of parts that enter into the conſtruction of the heavens, reſerving a more complete diſcuſſion of each to a future time. The firſt ſpecies are inſulated ſtars; as ſuch the author conſiders our ſun, and all the brighteſt ſtars, which he ſuppoſes nearly out of the reach of mutual gravitation; for, ſtating the annual parallax of Sirius at 1″, he calculates that Sirius and the ſun, if left alone, would be 33 millions of years in falling together; and that the action of ſtars of the milky way, as well as others, would tend to protract this time much more. Dr. Herſchel conjectures that inſulated ſtars alone are ſurrounded by planets. The next are binary ſidereal ſyſtems, or double ſtars: from the great number of theſe which are viſible in different parts of the heavens, and the frequent apparent equality of the two ſtars, Dr. Herſchel calculates the very great improbability that they ſhould be at diſtances from each other at all comparable to thoſe of the inſulated ſtars: hence he infers that they muſt be ſubjected to mutual gravitation, and can only preſerve their relative diſtances by a periodical revolution round a common centre. In confirmation of this inference he promiſes ſoon to communicate a ſeries of obſervations made on double ſtars, ſhowing that many of them have actually changed their ſituation in a progreſſive courſe, the motion of ſome being direct, and of others retrograde. The proper motion of our ſun does not appear to be of this kind, but to be rather the effect of ſome perturbations in the neighbouring ſyſtems. The ſame theory is next applied to triple, quadruple, and multiple ſyſtems of ſtars, and particular hypothetical caſes are explained by diagrams. Some ſuch caſes, Dr. Herſchel is fully perſuaded, have a real exiſtence in nature. The fourth ſpecies conſiſts of cluſtering ſtars, and of the milky way: the ſtars thus diſpoſed conſtitute maſſes, which appear brighter in the middle, and fainter towards the extremities, being, perhaps, collected in a ſpherical form. Groups of ſtars the author diſtinguiſhes from theſe by a want of apparent condenſation about a centre of attraction; and cluſters of ſtars, by a much more complete compreſſion near

ſuch

ſuch a centre, ſo as to exhibit a mottled luſtre, almoſt reſembling a nucleus. The eighth ſpecies conſiſts of nebulæ, which probably differ from the three laſt ſpecies only in being much more remote; ſome of them, Dr. Herſchel calculates, muſt be at ſo great a diſtance that the rays of light muſt have been nearly two millions of years in travelling from them to our ſyſtem. The ſtellar nebulæ, or ſtars with burs, form a diſtinct ſpecies. A milky nebuloſity is next mentioned, which may in ſome caſes reſemble other nebulæ, but in others appears to be diffuſed, almoſt like a fluid: the author is not inclined to conſider it as either reſembling the zodiacal light of the ſun, or as of a phoſphoreſcent nature. The tenth ſpecies is denominated nebulous ſtars; theſe are ſtars ſurrounded with a nebuloſity like an atmoſphere, of which the real magnitude muſt be amazingly great; for the apparent diameter of one of them, deſcribed in the catalogue, was 3′. The planetary nebulæ are diſtinguiſhed by their equable brightneſs and circular form, while their light is ſtill too faint to be produced by a ſingle luminary of great dimenſions. When they have bright central points, Dr. Herſchel conſiders them as forming a twelfth ſpecies, and ſuppoſes them to be allied to the nebulous ſtars, which might approach to their nature, if their luminous atmoſpheres were very much condenſed round the nucleus.

On the 8th of July, the firſt part of a paper on the rectification of the conic ſections was laid before the Society by the Rev. John Hellins, B.D. F.R.S. It contained nine theorems for the rectification of the hyperbola by means of infinite ſeries, one only of which had been before publiſhed, each having its particular advantages in particular caſes of the proportions of the axis and of the ordinates, ſo that they appear to contain a complete practical ſolution of this important problem, and they are illuſtrated by a variety of examples.

On the ſame evening were read obſervations on heat, and on the action of bodies which intercept it, by Mr. Prevoſt, profeſſor of natural philoſophy at Geneva. They conſiſt chiefly of inferences from Dr. Herſchel's important experiments on the tranſmiſſion of heat by different refracting mediums, eſpecially the different kinds of glaſs. Mr. Prevoſt ſets out with the law of the interchange of heat as aſcertained by the experiments of MM. Kraft and Richmann, that while the time flows equably, the differences of the temperature of two contiguous bodies flow proportionally, or are in geometrical progreſſion. Hence from three obſervations of the actual temperature of a thermometer, at given intervals of time, we may determine the progreſſion of the differences, and conſequently the actual heat of the medium. The au-

thor applies this method to Dr Herſchel's experiments on the heat of a ſolar ray tranſmitted through different mediums, and the concluſions are very different from what we ſhould at firſt ſight infer: for inſtance, in Dr. Herſchel's 24th experiment, the blue glaſs intercepted one-tenth only of the rays of heat, and not one-fourth, as the thermometer ſeemed to indicate. But the immediate interception muſt have been ſomewhat greater than one-tenth, for a certain portion of heat actually communicated to the glaſs muſt have radiated afreſh towards the thermometer, and contributed to produce the temperature obſerved; and accordingly as this circumſtance took place in a greater or leſs degree, the thermometer muſt have been variouſly and irregularly affected. Of ſuch an irregularity almoſt every one of the experiments ſhows evident marks; and the apparatus is not minutely enough deſcribed to furniſh data for calculating its magnitude. From theſe principles an experiment of Mr. Pictet on the interception of heat, is reconciled with Dr. Herſchel's experiments.

In the ſecond part of this paper Mr. Prevoſt treats of the reflection of heat and of cold. He obſerves that Bacon ſuggeſted the inquiry reſpecting the concentration of inviſible heat by glaſſes. Lambert attributed the effect of the reflection from a common fire to its inviſible heat. Mr. de Sauſſure ſuggeſted to Mr. Pictet to confirm Lambert's ſuſpicion by experiment, and the ſucceſs is well known. His experiment on the reflection of cold Mr. Prevoſt has already employed in ſupport of the opinion that the equilibrium of heat is not a quieſcent equilibrium, or an equilibrium of tenſion, but an equilibrium of motion, where the interchanges of heat on either ſide are equal; and this theory has been adopted by profeſſor Pictet, and by other philoſophers. Hence the author endeavours to deduce the law already inferred from Richmann's experiments. Mr. Prevoſt obſerves that this theory would be equally applicable to the opinion of thoſe who conſider heat as conſiſting in the undulations of an elaſtic medium; although he thinks that opinion liable to many objections, eſpecially on account of the reſiſtance which the motions of the planets muſt ſuffer from it. In a note added by Dr. Young, who communicated the paper, the aſſertion of Newton is quoted in anſwer to this objection, yet Doctor Young confeſſes that Newton appears to have calculated erroneouſly; but he obſerves, that if the ſlighteſt difficulty of this kind ſhould occur from aſtronomical conſiderations, it might be avoided by conſidering the luminiferous ether as unconcerned in the phænomena of coheſion, and then its rarity might be aſſumed as great as we chooſe to make it.

The Society adjourned to November 4.

FRENCH

FRENCH NATIONAL INSTITUTE.

Account of the labours of the Mathematical and Phyſical Claſs, during the ſecond quarter of the year 10.—Continued from No. 47.

Zoology.—C. Cuvier communicated to the claſs a great number of obſervations, which he made on the worms which contain a greater or leſs quantity of red blood, and ſimilar to that which circulates in animals that have vertebræ. A fluid more or leſs red had long been remarked in the earth-worm; but, as a fluid of the ſame colour had been ſeen in the larvæ of ſeveral inſects, it was not known whether that of the earth-worm was real blood. About four years ago C. Cuvier removed all doubt on this ſubject, and, after deſcribing the vaſcular ſyſtem of the earth-worm and leech, proved that the red fluid of theſe two animals is a real ſanguine fluid. In the courſe of laſt autumn this naturaliſt was enabled to extend his reſearches on this part ſo intereſting to the phyſiology of animals. He obſerved phænomena far more general, and conſequently more remarkable, than thoſe he had diſcovered before. He found that all articulated worms, ſuch as the naïades, nereïdes, aphrodites, amphinomes, terebellæ, amphitrytes, and ſerpules have red blood; that this fluid circulates in a complete ſyſtem of arteries and veins, and that it proceeds to the branchiæ, or to the ſurface of the ſkin, to aſſume a red colour, by an operation analogous to reſpiration in man and animals with vertebræ.

Medicine.—C. Percy, aſſociate, read medical and philoſophical obſervations on an univerſal ancyloſis, or immobility of all the articulations, and exhibited to the claſs the ſkeleton of the unfortunate ſubject, who lived twelve years in that ſtate, worſe than death, of which, according to C. Percy, it was a dreadful image and a long precurſor.

This ſurgeon in chief of the armies, after quoting inſtances of ancyloſis obſerved by different phyſicians, and particularly by Réal, Colomb, and C. Portal, informed the claſs that C. François-Maurice Marcieu de Simorre, an officer in the army, had contracted, during the campaigns in Corſica, a rheumatic gout which ſucceſſively deprived him of the uſe of his fingers, hands and feet; which, after producing the moſt violent pain, made it impoſſible for him to move any part of his body, and even his lower jaw; and which at length put an end to his exiſtence. He ſpent ſeveral years in an eaſy chair, without enjoying a moment's ſleep, notwithſtanding the ſtrongeſt doſes of opium. Being reduced to ſuch a ſtate, as to be able to ſuck only a little ſoup or wine through

the ſmall interval left between the upper and lower teeth; he cauſed two of the inciſive teeth to be drawn, and by means of the aperture produced by this operation, he ſpoke with more freedom, and could ſuck up liquids through a pipe, and even ſwallow a little minced meat.

His body, a kind of animated ſtatue, or living carcaſe, formed only one piece; all his bones were cemented to each other: and notwithſtanding this ſtate of extreme miſery, Simorre often converſed with great cheerfulneſs, and dictated every year an almanack in verſe, which the public eagerly bought up, to relieve his misfortune without wounding his delicacy. That of the year 5 was diſtinguiſhed by the following motto:

> Privé de la lumière, et perclus de ſon corps,
> Il ſe rit de la vie, en attendant la mort.

Simorre's countenance, however, diſplayed great expreſſion, and even hilarity. The muſcles of his face had acquired a ſingular mobility; they were continually in action, either to ſupply the want of geſtures, which he could no longer employ, or to wrinkle his ſkin and drive away the inſects which continually tormented him.

C. Percy has deſcribed the origin and progreſs of this diſeaſe, fortunately very rare: he has examined the cauſes and explained the alteration of the bones, and particularly thoſe of the articulations of Simorre, whoſe ſkeleton, a terrible and at the ſame time valuable monument of human miſery, is now depoſited in the conſervatory of the ſchool of medicine at Paris.

In a ſecond memoir C. Percy has deſcribed all the effects of a monſtrous voracity, to which he gives the name of *polyphagia*. A young man, in the environs of Lyons, named Tararé, at an early period of life, having followed a company of mountebanks, had accuſtomed himſelf to ſwallow pebbles, large offals of meat, coarſe fruits, knives, and even living animals. Terrible colics and other violent affections were not able to make him renounce this dangerous habit, which ſoon became an imperious want.

Having enliſted in the beginning of the laſt war in one of the battalions of the army of the Rhine, he fought in the neighbourhood of a flying hoſpital the neceſſary aliment. The refuſe of the kitchen, the remains of the ſoldiers' allowance, rejected articles and putrid proviſions were not ſufficient to ſatiate his appetite. He often conteſted with the vileſt animals for their diſguſting food, and he was in the continual purſuit of cats, dogs, and ſerpents, which he devoured

voured alive. It was neceſſary to drive him away by force or threats from the apartments of the dead, and from the places where the blood drawn from the ſick had been depoſited. Attempts were made, but in vain, to cure this voracity, by giving him in turns fat bodies, acids, opium, and even *la coque du Levant*. The diſappearance of a child ſixteen months old having excited ſtrong ſuſpicions againſt him, he deſerted: but in the year 6 he was admitted into the hoſpital of Verſailles, in a ſtate of conſumption, which had ſucceeded this horrible appetite, and which, according to his own account, was occaſioned by a ſilver fork that had remained in the inteſtinal canal.

As he died ſoon after, C. Tuſſier, chief ſurgeon of that hoſpital, had the courage to open the body, notwithſtanding the inſupportable odour which it exhaled: but the fork was not found. The ſtomach was of an extraordinary ſize; the inteſtines, completely ulcerated, exhibited remarkable ſwellings; and the gall-bladder was of a very great capacity.

Tarare was of a ſmall ſtature, delicate and weak; his look had nothing in it ſavage. When young, the ſkin of his belly could almoſt be wrapped round his body, and after a full meal one might have almoſt believed him to be dropſical: a thick vapour iſſued in torrents from his mouth, his whole body ſmoked, the ſweat flowed in abundance from his head, and, like ſeveral of the moſt voracious animals, he fell aſleep to digeſt.

C. Percy terminated his memoir by explaining the internal organization of thoſe wretches condemned by nature to experience this cruel and inordinate hunger: he explained the greater part of the phænomena they exhibit; and he concludes, from numerous inſtances of *polyphagia* which he has collected, that the unfortunate perſons ſubject to it, find, for the moſt part, an end to their torments by death, before they attain to the age of forty.

Account of the labours of the Claſs of the Phyſical and Mathematical Sciences during the third quarter of the year 10.

ASTRONOMY.—*Obſervations on the new Planet diſcovered by M. Olbers, of Bremen; and the Oppoſition of Ceres, the Planet diſcovered by M. Piazzi.*

A conjecture as eaſy to be formed as uſeleſs to aſtronomy had given reaſon to preſume the exiſtence of a planet betwen Mars and Jupiter; but the law which aſtronomers were pleaſed to eſtabliſh from the diſtances of the planets

known, appeared verified for a moment by the diſcovery of Piazzi's planet, but was ſoon belied in the moſt formal manner by the obſervation of a new planet very near the firſt. Here then we have an inſtance of the fall of opinions founded on deceitful analogies, and on the falſe ideas which we form of what conſtitutes order and regularity in the deſigns of nature. It will doubtleſs not cure men of the propenſity they have to indulge in vain ſpeculations, which, after making a noiſe for a while, ſoon fall into the deepeſt and well merited oblivion; and notwithſtanding the numerous leſſons which the poſitive ſciences never ceaſe to offer, they will always be found ſearching for the cauſes of effects when the data neceſſary for that purpoſe are entirely wanting, and even when no relations perceptible to our ſenſes ſeem to be connected with the nature which they aſſign to the unknown cauſe.

The new ſtar of which we here ſpeak, exhibits one remarkable ſingularity, which contradicts the ſyſtems conceived to explain the formation of the planets according to the probability of a cauſe in virtue of which their orbits have been confined within a very narrow zone, named the zodiac. The great inclination of the orbit of this ſtar obliges us to extend conſiderably the breadth of the zodiac; and gives reaſon to believe that it has perhaps no boundaries: theſe reflections are founded on the following facts borrowed from Delambre.

"On the 20th of Germinal, C. Burckhardt having received information that M. Olbers, of Bremen, had diſcovered a new ſtar, which had the appearance of a planet, he communicated this intelligence the ſame evening to all the aſtronomers of the Inſtitute, who ſought for it the night following. Next day, C. Meſſier, Mechain and Delambre gave to the claſs an account of their obſervations: the new ſtar had a ſenſible motion, both in right aſcenſion, and declination. It preſented no appearance of a tail, nor even of a nebuloſity, and could be diſtinguiſhed by nothing but its movement from ſtars of the eighth magnitude which were in its neighbourhood. They continued to obſerve it in the meridian till towards the end of Floreal: it always preſented the ſame appearances, only that its light was ſtill weaker, becauſe it began to recede from the earth.

"Attempts were made, but in vain, to find a parabola which would correſpond with the obſervations. A circle was attended with no better ſucceſs. An ellipſe was neceſſary, and one even very eccentric. In this reſpect the new planet differs very little from Mercury; but what is more extraordinary in regard to it is, that its inclination is about 35°, while that of

of Mercury is only 7, and that of the planet Ceres diſcovered in 1801 by Piazzi, 10° 37′. Thus we ſhall be obliged to enlarge conſiderably the zodiac, if we continue to denote by that name the zone of the heavens in which the planets perform their revolutions. Another very remarkable peculiarity is, that the mean diſtance of this planet differs very little from that of Ceres. We are not yet acquainted in the ſolar ſyſtem with two planets the orbits of which are ſo near.

" So many ſingularities render this new planet highly intereſting to aſtronomers; for it is beſides ſo ſmall, that it can have no ſenſible influence on the neighbouring planets: while, on the other hand, it muſt experience very conſiderable perturbations from Jupiter. C. Burckhardt has kept an account of the principal of them, in order to determine an elliptical orbit. We have indeed great need of a pretty correct theory, to be able to find this planet when it ſhall iſſue from the ſolar rays, into which it is about to enter; otherwiſe its ſmall ſize would render the ſearch for it very uncertain. It is even highly probable that it would have remained ſtill a long time unknown, had it not been found exactly in the place which Ceres had quitted, and quite cloſe to ſtars which had been much obſerved by aſtronomers for ſeveral months. It was a curious union, that of three new planets with which aſtronomy has been enriched in our days, they were all three ſeen to paſs the meridian in a few minutes of time. M. Olbers has given to his planet the name of Pallas."

The perfection to which inſtruments and methods are now carried, has enabled aſtronomers to deduce from a ſmall number of obſervations, the determination of the elements of the planetary orbits, which they were formerly obliged to leave to future ages. One of theſe ſtars is no ſooner diſcovered, than its motions are aſſigned with remarkable preciſion, as is proved by the oppoſition of Ceres, or Piazzi's planet, obſerved at the military ſchool by Lalande junior and Burckhardt.

They have determined the moment of the oppoſition, on the 26th of Ventoſe, year 10 (March 17th 1802), at 3^h 46′ 8″ mean time of the national obſervatory, Paris.

The true longitude freed from the effects of aberration, nutation and parallax, 176° 21′ 26″·5
Northern geocentric latitude 17 7 57·5

The tables conſtructed by C. Burckhardt, differed from obſervation + 5″·4 in latitude, and + 21″·8 longitude. The latter of theſe errors indicates that the radius vector muſt be a little increaſed; but the author ſtill waits for new ob-

ſervations before he can make the neceſſary corrections. In the calculation of this oppoſition, C. Lalande junior and Burckhardt from three obſervations of the ſun which agreed very well, diminiſhed by 11″ the longitude of this planet given by the tables.

MATHEMATICS APPLIED TO PHILOSOPHY.—*Remarks on the Difference between the Velocity of Sound deduced from Theory and that given by Obſervation. New Demonſtrations of the principal Theorems in regard to the Attraction exerciſed by Spheroids; ſpecial Determination of the Conditions of the Equilibrium of a Body made to balance freely on a Flexible Wire or on a Fluid.*

The reſult found by Newton for the velocity with which ſound is propagated in the atmoſpheric air, and ſince confirmed by various analytical reſearches of ſucceeding geometricians, differs however about a ninth from that given by experiment: the former is only 297·2 metres, and the ſecond is comprehended between 337·2 metres and 350·8. This point of philoſophy being one of thoſe to which analyſis applies with the greateſt rigour, it was impoſſible to aſcribe to the errors or imperfection of calculation, the difference between theory and obſervation. Newton therefore himſelf and ſome of the philoſophers who wrote after him on this ſubject have formed different hypotheſes, in regard to the conſtitution of the atmoſphere, in order to account for the difference in queſtion. But as none of theſe hypotheſes, which explained the fact only in a very vague manner, could accord with the diſcoveries of the modern chemiſtry, reſpecting the nature of the air, it has ſince been aſcribed to the influence which the variations of the temperature that accompany the dilatation and condenſation of the air reſulting from its vibrations may have on the velocity of ſound.

C. Biot, aſſociate, has endeavoured to determine by calculation, the effect which theſe vibrations that cannot be doubted, produce on the velocity of ſound. He has proved that it might be very ſenſible, and even ſufficient to carry the velocity of ſound beyond the term fixed by experiment. For this purpoſe he ſet out from ſome experiments on the dilatation of the air, and of gas, made under the direction of Berthollet, by C. Guy-Luſſac, and he has combined them with a plauſible hypotheſis on the quantity of calorie diſengaged by the compreſſion of the air, viz. that this fluid, under theſe circumſtances, abandons as much of it as is neceſſary to be taken from it by ſimple cooling in order to reduce it to the bulk it is made to occupy.

As

As this hypotheſis gives a reſult too great, C. Biot then reſumes the queſtion in an inverſe order, and, from the obſerved velocity of ſound, endeavours to find what ought to be the quantity of caloric abandoned by the air, when it is reduced by compreſſion to the half of its volume; and he finds that the ſame quantity would raiſe Reaumur's thermometer to about 69°.

C. Biot has communicated alſo to the claſs reſearches on the attraction of ſpheroids. This ſubject, treated firſt in a ſynthetic manner by Maclaurin, was a long time the quickſand of analyſis, which, however, in the hands of Lagrange, Legendre, and Laplace, has ſucceſſively aſſumed a ſuperiority over ſyntheſis, and conducted to reſults which could not have been obtained without its aſſiſtance. But there remained in the analytical demonſtrations of the principal theorems on this ſubject, a complication which C. Biot made to diſappear in a very happy manner, by combining a theorem, for which we are indebted to Lagrange, with a partial differential equation, found by Laplace, and applying to this equation a proceſs, which he preſented himſelf ſome years ago to the claſs, to integrate by ſeries partial differential equations.

The equation to which we allude is among three of the differential co-efficients of the ſecond order of the function which expreſſes the ſum of the moleculæ of the ſpheroid divided by their diſtance from the point attracted; its integration gives for this quantity a ſeries containing two arbitrary functions arranged according to the powers of one of the co-ordinates of the point attracted. By ſucceſſively taking, in regard to each of theſe variable quantities, the differential co-efficients of the ſeries which expreſſes the attractions exerciſed by the ſpheroid in a direction parallel to the axes of the co-ordinates, C. Biot obtained developments of theſe attractions, determined entirely by three quantities, independent of the variable one, according to the powers of which the developments are arranged.

It thence reſults, 1ſt, that to have the attractions of any ſpheroid on any point of ſpace, it is ſufficient to take at pleaſure a plane, and to calculate the attractions of the ſpheroid on the points ſituated in that plane: thoſe which are within the ſpheroid will determine the general expreſſion of its attraction on the interior points; the other will determine thoſe which belong to the exterior points.

2d, That if two ſpheroids are ſuch that their attractions on all the points of the ſame plane parallel to three rectangular axes are to each other in a conſtant ratio, the attrac-

tions of theſe ſpheroids on any point of ſpace will preſerve the ſame ratio.

Theſe general theorems, when the queſtion relates to revolving ſpheroids, are modified in the following manner:

To have the attraction of a revolving ſpheroid on any point of ſpace, it will be ſufficient to know theſe attractions on any point of a right line perpendicular to the axis of revolution, and drawn through a point, taken at pleaſure, in that axis.

If two revolving ſpheroids are ſuch that their attractions on any point of the ſame ſtraight line, ſubject to the preceding conditions, are to each other in a conſtant ratio, the attractions exerciſed by theſe ſpheroids on any point of ſpace will retain the ſame ratio.

C. Biot applies in ſucceſſion various theorems to any elliptical and revolving ſpheroids, and thence deduces the well-known theorems; then transforming, in a general manner, the variable quantities of his formulæ, he concludes, that to have the attraction of any ſpheroid on any point of ſpace, it is ſufficient to know, for the points of any ſurface that may be aſſumed at pleaſure, the two firſt terms of the development of the function which expreſſes the ſum of the moleculæ of the ſpheroid divided by their diſtance from the point attracted; and that, if there are two ſpheroids, the attractions of which on the ſame points of that ſurface are to each other in a ratio independent of the primitive co-ordinates, the attractions of the two ſpheroids on any point of the ſpace whatever will be to each other in the ſame ratio. He concludes his memoir by the application of theſe laſt theorems to revolving ſpheroids.

LI. *Intelligence and Miſcellaneous Articles.*

COMMERCIAL COLLEGE.

MANY of our readers will peruſe with ſome degree of intereſt the following propoſals for eſtabliſhing by ſubſcription a commercial college at Hull. It would give us much pleaſure to be able to announce that ſimilar inſtitutions were about to be eſtabliſhed in other places.

"The object of this inſtitution is, to obtain for the man of buſineſs preciſe information on the nature and value of every article of commerce, whether the raw material or manufactured: to point out to him the country where ſuch articles may beſt be procured: to bring him acquainted with the various proceſſes by which they are rendered marketable: and,

and, to inſtruct him in the languages of the different countries whither the objects of commercial purſuits may lead him.

" The plan is, to appoint profeſſors, to form a muſeum, and to erect a building for the accommodation of profeſſors, and the reception of ſpecimens of the raw materials and manufactured articles of commerce.

" One profeſſor to teach the ſouthern languages; a ſecond, the northern; and a third to have the charge of the muſæum, and to be capable of explaining to the pupils the various ſpecimens of nature and art under his care.

" Every ſubſcriber of fifty pounds to be a governor, and to poſſeſs a right of transferable property in the building, and to have the privilege of appointing pupils.

" Subſcribers of twenty pounds to have the power of recommending pupils during life; and ſubſcribers of two guineas to be conſidered as annual ſubſcribers, and, for the time, to have the power of recommending .

" In order to render the profeſſors independent of gratuitous ſubſcription, I propoſe that the three corporations of the town ſhould each endow a profeſſorſhip with fifty pounds per annum, and, in return, that they ſhould each have the privilege of recommending a certain number of the poor, intended for commercial purſuits, or the ſea, to all the advantages of the inſtitution.

" To obtain a royal charter of inſtitution.

" The eſtimated expenſe is:

For ground and building - -	£. 2000
For collecting ſpecimens and fitting up the muſæum	500
	£. 2500

" It will perhaps be thought by many that the foregoing ſtatement does not hold out ſufficient intereſt to warrant a man in putting down his money for the purpoſes; and by others, that charitable inſtitutions are already ſufficiently numerous in the town; and that thoſe eſtabliſhed have the firſt claim to our benevolence. To the latter I need only ſay, I do not conſider the preſent inſtitution as a charitable one; and to the former, that I hope to prove it will eventually be the real intereſt of every ſubſcriber.

" As the father of a large family, I certainly ſhould not think myſelf at liberty to ſubſcribe fifty pounds merely for the perſonal pleaſure that reſults from the contemplation of a charitable action; but in ſubſcribing fifty pounds to the above inſtitution, I conſider my intereſt and the welfare of my family. I am convinced it will add to the wealth and importance

importance of the town; and in both of these I am deeply interested: but the greatest interest I have is in the facility it will give to the education of my children. In a commercial country and a seaport town, the acquisition of knowledge, that evidently leads to the improvement of trade, becomes an object of the first moment in the education of youth, and the mode now proposed offers advantages which no private school can possess. To bring together under the immediate observation of youth, (while yet the memory is most retentive,) perfect specimens of the different articles of commerce, both of the raw material and the manufactured, will enable him to bear in mind the precise value of any article he may be called upon to appreciate: to point out the country where every article is first procured or manufactured, will qualify him to go to the cheapest market; and, by teaching him the language of such country, he will be at all times capable of transacting his own concerns without the intervention of interpreters, often a very serious source of imposition.

"The views and pursuits of the different public bodies in the town are now so enlarged and liberal that I have no doubt, should there be a sufficient number of subscribers, they will be induced to do their part from the conviction that they thereby pursue the positive if not immediate interest of their respective charges.

Hull, May 13, 1802. J. Alderson, M.D.

"Subscribers' names will be received at the Library, at the Banks, and at Messrs. Rawson and Rodford's, booksellers, Lowgate; and as soon as there are twenty subscribers a meeting will be called."

VACCINE INOCULATION IN WALES.

The following account has been communicated from the learned Dr. W. Turton, being an extract from a printed paper distributed in Swansea.

"Having very nearly lost my son in the small-pox from inoculation, I was naturally uneasy about the event of it in my daughter; and went to London, anxious to make the most minute inquiries concerning the success of the cow-pock, then lately established. I examined the different hospitals and institutions where it was practised, carefully watched the progress of the disease, and attended Dr. Pearson to the villages near Oatlands, where upwards of three hundred people, who never had the small-pox, were inoculated for the cow-pock by the recommendation of the Duke: all of these were again inoculated for the small-pox, and without effect.

effect. Every ſcruple was therefore removed, and I deſired Dr. Pearſon to ſend me, in a letter, ſome of his genuine matter on a thread, that I might inoculate both my own children, for the ſatisfaction of all who might wiſh to have evidence of its effects: and (June 29, 1799) in the preſence of Mr. J. Collins, Mr. Braine, and the late apprentice of Mr. Sylveſter, I inoculated them both. The boy, who before had had the ſmall-pox, did not take it; but the little girl, who never had either, went well through it, without any previous preparation, without any alteration in her food or manner of living, and with only about two hours illneſs. She has ſince been inoculated for the ſmall-pox, and expoſed in every manner to its infection, but it is certain cannot have it.

"From her arm I inoculated ſeveral children, among whom were two of Mr. Ayrton's; each of which I directed might ſleep with one who never had been inoculated for either. The two that were inoculated went well through it, and the two that ſlept with them did not catch it. By this it appears that it is not infectious, and that any part of a family may have it without communicating it to others.

"An opinion has been delivered about the town, that it is poſſible for thoſe who have had the cow-pock ſtill to be liable to have the ſmall-pox. This I may ſafely contradict; as it is an aſſertion made without proof, or without inquiry after proof: for, notwithſtanding every eye has been open to diſcover whatever might happen, and every attempt made to aſcertain it, there is not upon record one ſingle inſtance.

"Had thoſe who have lately been cut off by the ſmall-pox in Swanſea been inoculated for the cow-pock, it is more than probable they would all have been ſaved: and in conſequence of its increaſing fatality I was applied to by many, who truſted my aſſertions, to procure genuine matter from London. I have juſt received ſome from Dr. Pearſon, and have inoculated the children of Capt. Nichols, on the Burrows, and the two others of Mr. Ayrton, who may be ſeen by any one deſirous of further information. From them I am willing to inoculate ſuch as are fully convinced of its utility, and pledge myſelf, under Providence, for their ſafety.

"Obſtructions from medical men will ſometimes preſent themſelves, through prejudice, or fear, or intereſt. Prejudice I conſider to be a determination to abide by old opinions whether right or wrong: and with men who perſevere in detected error, it is uſeleſs to reaſon, and fooliſh to contend. Fear will operate with thoſe who are apprehenſive of

of introducing and recommending what they do not clearly underſtand, and about which they are too idle to make inquiries. And, I am afraid, a few will be found, who regarding their annual harveſt from the ſmall-pox as likely to be diminiſhed or totally loſt, will honeſtly endeavour to extinguiſh the light that would conduct their fellow-beings to ſafety.

Fiſher Street, March 19, 1800.

"POSTSCRIPT.

"After a lapſe of three years, the author of theſe obſervations cannot but congratulate himſelf and the public on the unequivocal ſucceſs which has attended his introducing the cow-pock into this country. Upwards of a thouſand perſons in the various towns of South-Wales have been inoculated, without the ſmalleſt accident or interruption to their health; and the uſual ravages from the ſmall-pox are manifeſtly diminiſhing every year.

Swanſea, June 9, 1802.

Extract of a Letter to Dr. Pearſon.

"MY DEAR SIR, Swanſea, Auguſt 6, 1802.

"You will ſee by the incloſed, how I from time to time promote the good cauſe. I have overcome all difficulties, and many thouſands have been inoculated without one accident or the leaſt apparent danger. In ſome towns the whole of the inhabitants, not having previouſly had the ſmall-pox, have confidently taken the cow-pock. The ſmall-pox has not appeared here for ſome time, and I hope the day is not far diſtant when it ſhall be declared criminal by the legiſlature to introduce it. Whatever may be the opinion of any individual as to the comparative ſafety of either, no man can now be juſtified in contaminating his neighbourhood.

"My eldeſt daughter, the firſt Cambrian ever inoculated for the cow-pock, I have lately chriſtened Vaccinia—an unalterable record of its introduction and by whom.

"Ever yours, W. TURTON."

INTERNAL IMPROVEMENTS.

On the 27th. of Auguſt the magnificent docks at Blackwall, which, in ſize and accommodation to ſhipping, exceed every thing that now exiſts, were opened for the reception of the ſhipping in the Weſt-India trade.

By eleven o'clock the various avenues and roads leading to the Iſle of Dogs were crowded by multitudes, ſome on horſeback, others in gigs and curricles, but the greateſt number were pedeſtrians. The buſtle and confuſion in repairing to Blackwall

Blackwall were aſtoniſhing. A little after twelve o'clock, ropes were thrown to the people on ſhore, in order to tow the Henry Addington, a Weſt-Indiaman lately launched, into the dock. The people laid hold of the cords; but the veſſel being large and heavy, it was ſome time before ſhe could be moved, notwithſtanding the Echo, a veſſel from the Weſt Indies deeply laden, had entered the great baſon ſoon after eleven o'clock. By the ſtrenuous exertions of the people on ſhore, aided by a windlaſs on each ſide of the great floodgate, the veſſel was at laſt brought near the entrance of the dock. She was greeted by the populace on each ſide with loud and reiterated huzzas, and by the band of muſic belonging to the firſt regiment of guards, who played "See, the conquering hero comes!"

The veſſel being by this time very near the great floodgate, a conſiderable delay took place before ſhe was introduced to the dock. This, however, having been overcome, the people once more "gave way," and the ſhip came in amidſt the ſhouts of the ſpectators, the band playing "God ſave the King," "Rule Britannia," &c. &c. We never witneſſed any thing more ſtriking, and at the ſame time ſo very pictureſque, as the paſſage of this veſſel into the dock. She was decorated in the moſt ſplendid manner by the flags of all nations diſplayed in various parts of her rigging. Having come to her moorings at the firſt ring-bolt-buoy, ſhe fired a royal ſalute, which was anſwered by the ſhouts and huzzas of the ſpectators.

The Echo, a veſſel, as we have mentioned above, deeply laden from the Weſt Indies, was next towed in. She is a very handſome ſhip, and was received with the loudeſt expreſſions of joy. Upon this veſſel reaching her ſtation, another ſalute was fired from the Henry Addington, which concluded the buſineſs of the docks. In the afternoon the company on board the veſſels, and the various proprietors and commiſſioners of the docks, repaired to the London tavern, where a moſt elegant dinner was provided for their entertainment.

The whole of the ſcene muſt have been highly gratifying to every well-wiſher to the greatneſs of this country. In the ſhort ſpace of two years, by the energy, the ſpirit, the wealth, and the perſeverance of individuals, this imperial work, the proof of paſt and the pledge of future proſperity, has been begun and almoſt finiſhed. New facilities to commerce are thus created from its former acquiſitions, and a freſh activity is given to induſtry and to enterpriſe. While property is thus rendered active by liberty, and maintained ſecure by law (and what other ſource has commerce had in

this

this country but liberty and law?) it is impoſſible to ſet bounds to its operations and to its ſucceſſes.

At a public meeting held at Horſham in Suſſex on the 18th of Auguſt, it was reſolved, That acts of parliament having been already obtained for making a canal navigation from the Thames at Rotherhithe to Croydon in Surry, it is deſirable that a canal ſhould be made, to commence at the termination of that canal at Croydon, and to paſs from thence to Portſmouth. A ſubſcription was immediately ſet on foot to carry the deſign into execution.

A very numerous and reſpectable meeting of gentlemen, merchants, bankers, and others, was held at the Crown and Anchor in the Strand, on Thurſday the 5th of Auguſt, to conſider of the expediency of applying to parliament for an act to make a navigable canal from the grand junction canal at Paddington, round the north of London, to communicate with the London Docks at Wapping. Sir Chriſtopher Baynes, bart. was called to the chair, and laid before the meeting a very ſatisfactory ſtatement, not only of the plan propoſed, but of the means by which it may be accompliſhed, together with eſtimates of the expenſe likely to attend its completion; after which a committee of ſubſcribers was appointed to take the neceſſary meaſures for carrying the plan into effect. We forbear, in this early ſtage of ſo important an undertaking, to prognoſticate the various benefits that may ariſe from it, although there ſeems an univerſal opinion in its favour.

We hope alſo to be able, at no very diſtant period, to announce that the iron bridge of one arch over the Thames, projected by Mr. Telford, is to be undertaken. A perſpective view of the bridge has been publiſhed on a very extenſive ſcale. It is an admirable production, eſpecially the engraved part *. It has received the approbation of the moſt eminent mathematicians, as Dr. Maſkelyne, Dr. Hutton, Mr. Robertſon of Oxford, Mr. Atwood of London, Dr. Robiſon and Mr. Playfair of Edinburgh, and Mr. Coupland of Aberdeen; which is a ſufficient juſtification of the principles of the deſign. Among the great, the king, the prince of Wales, the duke of York, and the duke of Kent, have ſtood foremoſt in their approbation. The plate is now dedicated to his majeſty, by his permiſſion, and with the approbation of lord Hawkeſbury, to whom it was at firſt dedicated.

If to the docks in the Iſle of Dogs, and in Wapping, this improvement in the upper part of the river was added, the

* The back ground is in aquatinta.

port of London would be the moſt perfect in the world. The city would be accommodated with wharfs and warehouſes in its centre, and the bridge would be a feature to diſtinguiſh it from other cities. The completing the work of peace, the intended diſſolution of parliament, together with the neceſſary abſence of Mr. Telford in making ſurveys in Scotland, prevented the buſineſs of the bridge from being brought forward during the laſt ſeſſion; but it will probably in the courſe of the next, or at leaſt as ſoon as the ſcheme can be fully matured.

The Scotch ſurveys relate to improving and extending the fiſheries; eſtabliſhing or improving harbours on the eaſt and weſt coaſts for commercial and naval purpoſes; opening an inland navigation from the Murray-frith to the bottom of the Sound of Mull, with a depth of water ſufficient to carry the largeſt Baltic men, Weſt-India men, and frigates; improving the land communications in the north by means of roads and bridges; inquiries into the cauſe of emigrations, and modes to prevent them; and improving the communications between Ireland and the weſt of Scotland and the north of England. The ſurveys are ſtill going on.

Theſe are certainly objects of national importance, and miniſters deſerve credit for beſtowing attention upon them. They embrace a great portion of our internal improvements, on a ſcale which promiſes to promote the proſperity of the Britiſh empire.

The opening the Caledonian canal would admit of the whole of the trade from the weſt of England and Scotland, and the whole of Ireland, paſſing in a direct and eaſy manner to and from the Baltic, inſtead of being expoſed to the ſtormy and dangerous navigation of the Pentland frith, the Orkneys, and northern parts of Scotland, which are particularly expoſed in the time of war: and a naval ſtation at Cromarty, Peterhead, or Aberdeen, would afford ready convoys, and guard the entrance of the Baltic; while the bay of Oban, on the coaſt of Argyle, would afford a ſafe ſhelter on the weſt coaſt. Nature has pointed out this line of country as particularly ſuitable for a canal of this magnitude, the diſtance between ſea and ſea being about 60 miles, in a direct line, out of which upwards of 37 miles are now navigable locks capable of admitting ſhips of the largeſt dimenſions; and the greateſt height above the level of the ſea does not exceed 100 feet. The locks on and above the ſummit-level form reſervoirs of about 20 miles in length; and the waters of a large diſtrict of rainy country fall into the locks which form this reſervoir.

This

This inland navigation would alſo open a ready paſſage for the fiſhers of the Eaſt coaſt, to paſs to the fiſhing-grounds on the Weſt coaſt, and of courſe for thoſe who reſide on the Weſt to paſs to the Eaſt ſide of the iſland; ſo that the whole would be as it were under one eſtabliſhment. The executing the works connected with the inland navigation, the harbours, and bridges, would employ the people of the country, give them habits of induſtry, furniſh them with capital for future employment, and be the beſt means of preventing emigration.

LECTURES.

In the ſecond week of October next, will commence at the Elaboratory in Whitcomb Street, Leiceſter Square, a Courſe of Lectures on Phyſic and Chemiſtry at the uſual morning hours, viz:

The Therapeuticks, or Materia Medica, at a quarter before eight.

The Practice of Phyſic, at half after eight.

The Chemiſtry, at a quarter after nine.

By George Pearſon, M. D. F. R. S. ſenior phyſician to St. George's Hoſpital, of the College of Phyſicians, &c.

On the firſt Tueſday evening in October and February, Mr. Blair will begin his Courſe of popular Lectures on Anatomy and the Animal Economy, for the information of ſcientific perſons, amateurs of natural hiſtory, ſtudents in the liberal arts, and profeſſional men in general; and on the firſt Friday in October and February his courſe of lectures on the Clinical Practice of Surgery.

The following Courſes of Lectures will be delivered at the Medical Theatre of St. Bartholomew's Hoſpital, during the enſuing winter:

On the theory and practice of Medicine, by Dr. Roberts, and Dr. Powell.

Clinical lectures on caſes occurring in the Hoſpital will be delivered by Dr. Roberts.

On Anatomy and Phyſiology, by Mr. Abernethy.

On comparative Anatomy and Phyſiology, by Mr. Macartney.

On the theory and practice of Surgery, by Mr. Abernethy.

On Chemiſtry and the Materia Medica, by Dr. Powell.

On Midwifery and the Diſeaſes of Women and Children, by Dr. Thynne.

The Anatomical Lectures will begin on the 1ſt of October at two o'clock, and the other Lectures on the ſucceeding days, which, with all other particulars may be learned by applying to Mr. Nicholſon, at the apothecary's ſhop, St. Bartholomew's Hoſpital.

LII. *On the Virgula Divinatoria, or Divining Rod. By* WILLIAM PHILLIPS, *Esq. Read before the Askesian Society in the Session* 1801.

THE *virgula divinatoria*, or divining rod, is a forked branch, or two shoots or young branches of a fruit-bearing tree, tied together at one end, and held by the other ends one in each hand. When held in a certain position, and under certain circumstances, which I shall endeavour presently to describe, it is said to discover the situation of metals, &c. in the earth, by dipping as it approaches the place beneath which they immediately lie.

It is not known who was the discoverer of it; but Agricola, in his Treatise *De Re Metallica*, supposes that it took its rise from the magicians, who pretended to discover mines by inchantment: others are of opinion that the discovery is of later date, and that the inventor was hanged in Germany as an impostor. Be that as it may, no mention is made of it earlier than the 11th century; and though it has occasionally occupied attention for so long a time, yet the niceties attending its use according to the prescribed directions, and probably, too, the difficulty of accounting for the effects said to be produced by any plausible theory consistent with the admitted laws of natural philosophy, may have retarded its progress; for it is now almost totally neglected.

About the middle of the 18th century it was ably supported in France by De Thouvenel, who published a book upon the subject, in which he endeavoured to substantiate the virtue of the divining rod by the recital of about six hundred instances of its successful employment, principally by himself or within his own knowledge; and soon after by a philosopher of unimpeachable veracity, and a chemist, William Cookworthy, late of Plymouth. The favourable opinion he entertained of it was grounded, according to his own account, as became a chemist, upon actual experiment. It appears that his experiments were frequently repeated, and that the ease which he attained in using the virgula was the means of his satisfying many intelligent men of its virtue, by experiments for the discovery of pieces of metal hid in the earth, as well as by the discovery of a copper mine near Oakhampton, which was worked for several years. Thus it became introduced into Cornwall, where the discovery of several mines is attributed to it; and there are yet a few among

among the moſt intelligent practical miners in the county who continue to believe in its virtue. The firſt knowledge he procured of the rod was from a captain Rebeira, who deſerted the Spaniſh ſervice in queen Ann's reign, and became captain commandant of Plymouth garriſon; and as Cookworthy's veracity and abilities were unqueſtionable, and as it undeniably appears that he made many experiments with the rod, it ſeems as if his account demands ſome degree of confidence. But the earlier writers who mention it, appear to have ſuppoſed that its operation was the effect of magic; and thence the cutting of it was, according to their directions, to be attended by the utterance of certain cabaliſtic words and the performance of certain ceremonies: they directed it to be cut on a certain day, and at a certain hour, from a tree of a certain deſcription, before ſun-riſe, about the day of the annunciation of the Virgin Mary, but eſpecially with an increaſing moon. It has, however, of later times been agreed, that a forked hazle rod, or two ſtraight rods of one year's growth, being moſt pliable, cut in the winter and kept till they are dry, anſwer beſt; or, if theſe be not at hand, ſuckers of the apple or currant-tree, or ſhoots of the peach-tree, willow, or oak, though green, will do tolerably well, but thoſe of the fruit-bearing trees are preferred. If the rod be made of two ſeparate ſhoots, they are tied together at their larger ends with ſome vegetable ſubſtance; and theſe, it is ſaid, anſwer better than thoſe which grow forked, the ſhoots of which, being rarely of equal ſize and length, do not handle ſo well. The length of the rod is from 2½ to 3 feet.

Upon a nice obſervation of the mode of holding the rod, preſcribed by Cookworthy, much ſeems to depend. Having, as has been obſerved, tied the larger ends of the ſticks together, the ſmaller are to be held one in each hand, with that part of it which is graſped by the hand ſo turned as to be brought parallel to the horizon, and the tied ends pointing upwards at an elevation of about 70 degrees. The more ſtrongly the rod is graſped, the livelier is ſaid to be its action: but it is peculiarly neceſſary to obſerve that it be graſped ſteadily and equally; for if, when the movement or attraction of the rod is commenced, there be the leaſt imaginable oppoſition to it by a jerk, it will not move any more till the hands have been opened and a freſh graſp taken. It appears that a due obſervance of this is of much importance, and that the operation of the rod has in many inſtances been defeated by a jerk or counter-action; and thence, ſays Pryce, in his *Mineralogia Cornubienſis*, who was "well convinced of its abſolute and improveable virtues,"

tues," it has been concluded that there is no real efficacy in the rod. It muſt, he ſays, be particularly obſerved, that as our animal ſpirits are neceſſary to this proceſs, ſo a man ought to hold the rod with the ſame indifference and inattention to, and reaſoning about it, or its effects, as he holds a fiſhing-rod, or a walking-ſtick; for, if the mind be occupied by doubts, reaſoning, or any other operation that engages the animal ſpirits, it will diveſt their powers from being exerted in the proceſs, in which their inſtrumentality is abſolutely neceſſary: hence, he obſerves, it is that the rod conſtantly anſwers in the hands of peaſants, women, and children, who hold it ſimply, without puzzling their minds with doubts or reaſonings. Whatever, adds he, may be thought of this obſervation, it is a very juſt one, and of great conſequence in the practice of the divining rod.

Equipped as has been deſcribed, and duly obſerving the foregoing directions, the perſon in ſearch of a metallic lode is to walk ſteadily and ſlowly forward; and when he approaches a lode ſo nearly as its ſemi-diameter, the rod, it is ſaid, will feel looſe in his hands, and be ſenſibly repelled towards his face: if it be thrown back ſo far as to touch his hat, it muſt be brought forward to its uſual elevation, when it will continue to be repelled till his foremoſt foot is over the edge of the lode: and when this is the caſe, if the rod be held well, there will be firſt a ſmall repulſion towards the face; but this is momentary, and the rod will be immediately drawn irreſiſtibly down, it is ſaid, and will continue to be ſo during the whole paſſage over the lode: but as ſoon as the foremoſt foot is beyond its limits (Pryce's *Mineralogia Cornubienſis*), the attraction from the hindmoſt foot, which is ſtill on the lode, or elſe the repulſion on the other ſide, or both, throw the rod back towards the face. When the rod has been drawn down, the hands muſt be opened, the rod raiſed by the middle fingers, a freſh graſp muſt be taken, and the rod held again as before; for, if it be raiſed again without opening the hands, it will not work.

Pryce, at p. 123 of his *Mineralogia Cornubienſis*, informs us that many mines have been diſcovered by means of the rod, and quotes ſeveral; but it muſt be obſerved that, by his own account of the adventures, not one of them turned out a profitable concern; and hence he takes occaſion to obſerve, that it is by no means a diſadvantage that the rod dips equally to a poor as to a rich lode, which he allows to be the caſe; otherwiſe the great prizes in the mining lottery would ſoon be drawn, and future adventurers be diſcouraged.

But though the rod is ſaid to dip equally to a poor as to a

rich lode, it is not found to dip with the ſame force to all metals; nor, indeed, does it appear to be confined to metals alone, but that it is alſo attracted by coals, bones, limeſtone, and ſprings of water, with different degrees of ſtrength, in the following order:—1. Gold: 2. Copper: 3. Iron: 4. Silver: 5. Tin: 6. Lead: 7. Coals: 8. Limeſtone and ſprings of water. The mode directed by Cookworthy for proving this is the following: With the rod held according to the preſcribed rules, ſtand with one foot advanced, put under it a guinea, and a halfpenny under the other, and the rod will be drawn down forwards: if the pieces of money be ſhifted, it will ſtill be attracted towards the gold, *i. e.* towards the face; which proves that the gold poſſeſſes the ſtronger attraction: and, by thus varying all the forementioned ſubſtances, the ſtrength of their reſpective attractions will be found to correſpond with the order in which they are placed.

According to captain Rebeira, the virtue neceſſarily reſident in the human body for the diſcovery of metals, &c. in the earth by means of the divining rod, is confined to but few perſons; and Agricola very ſhrewdly inſinuates, that where it does not act, it muſt be owing to ſome ſingular occult quality in the perſon. Cookworthy and Pryce, however, aſſert that Rebeira was miſtaken; for that the virtue, as he calls it, reſides in all rods and in all perſons, though not in every rod in the hands of every perſon. Willow and other rods, ſay they, not of fruit-bearing trees, that are not attracted in the hands of thoſe in which the fruit-bearing rods are attracted, will anſwer in the hands of thoſe in which the fruit-bearing rods are not attracted; ſo that all perſons poſſeſs the virtue.

If a piece of the ſame wood as that of which the rod is compoſed be placed under the arm, it will totally deſtroy the operation of it, except in the inſtance of water, for which any rod, they ſay, in any hand will anſwer; or if the leaſt animal thread, as ſilk, or worſted, or hair, be placed on the top of the rod, it will prevent its operation: but if a piece of the ſame animal ſubſtance, or of the ſame wood as that of which the rod is made, provided the rod does not anſwer, be placed under the arm, it will cauſe the rod to operate. If a piece of gold be held in the hand and touching the rod, it will prevent its being attracted by that metal or by copper, for the rod will be repelled towards the face; or if iron, lead, tin, ſilver, limeſtone, bone, or coal, be held in like manner, it will alſo be repelled, and *vice verſa*. If a perſon with whom the rod does not naturally operate hold a piece of gold in his hand, the rod then anſwers to gold and copper; and

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thus with reſpect to the other metals and ſubſtances; and upon theſe properties of the rod depends its power of diſtinguiſhing one metal or ſubſtance from another. Another mode however, grounded upon the ſame principles, is pointed out as being much more ready and certain, viz. by preparing rods that will only anſwer to ſome one of the aforementioned ſubſtances. The mode of preparing them is by boring a ſmall hole in the top of the rod, and by putting into it a very ſmall quantity of each ſubſtance except that after which ſearch is to be made: the hole is then to be ſtopped up with a piece of the ſame wood of which the rod is made. Theſe are the directions which Cookworthy has given for the uſe of the divining rod.

It is now but little if at all practiſed in this country: the few among the curious, or among practical miners, who continue to aſſert that it poſſeſſes an influence in the diſcovery of ores, ſeem ſo far to have yielded to its opponents as to have given up the uſe of it. Two with whom I became acquainted in Cornwall ſtill aſſert their belief in it, and that it has been the means of diſcovering mines there; and a third aſſured me that he had himſelf, by the accidental uſe of the rod, in a place where he did not expect that it would have been acted upon, viz. in his own ſhop, diſcovered a lode which is now working under the town of Redruth: but it muſt be acknowledged that there are many more among the moſt intelligent miners who ridicule the rod, than believe in the influence of minerals upon it. Taking it for granted, however, that metals do act upon the rod to the fulleſt extent of Cookworthy's belief, it ſtill remains a queſtion, notwithſtanding the accommodating opinion of Pryce, whether it would prove a benefit to the miner, as it is allowed that it dips equally to the poor as to the rich lode, to a ſilver penny as to the mines of Potoſi; for it is too often experienced in Cornwall that lodes are not wanting, but ore. The advantage to be derived from it, therefore, with regard to metallic veins ſeems by no means a counterbalance to the niceties and uncertainties attending its uſe; for the projector, implicitly depending upon the information of the rod, might, at a ruinous expenſe, ranſack the bowels of the earth, in conſequence of its dipping to a rich goſſan, or a dead lode.

Believing with Boyle, that they who have ſeen the experiment can much more reaſonably believe than they who have not, and being deſirous of annexing to this account of the divining rod any little teſtimonial of my own experience, which a ſedulous attention to the preceding directions might afford, I cut, during the laſt winter, a number of hazle rods,

and laid them by till they became dry; when, having tied two together with a vegetable ſubſtance, I proceeded to endeavour the diſcovery of ſome pieces of metal: but repeated trials, both by others and myſelf, afforded us no opportunity of becoming convinced by experience that metals poſſeſs any influence upon the rod; and we were obliged, in giving up the trial, to acknowledge that we poſſeſſed thoſe "ſingular occult faculties" which, according to Agricola, in ſome people prevent its action. It would, however, be an abſurd and unwarrantable concluſion, to aſſert that the accounts which have been handed to us have been fabricated merely to excite our wonder, becauſe thoſe effects which have been aſſerted to accompany the uſe of the rod occaſionally have not, in theſe few inſtances, been obſerved. Yet it has ſo long been conſidered the prerogative of human reaſon to deny what cannot be explained, that it is with much difficulty we can admit as fact, however reſpectable the authority, that of which we have no ocular or ſenſible teſtimony, or for which no phyſical cauſe has been aſſigned. Two centuries ago who would have believed in the exiſtence of the electric fluid? or who, if ocular demonſtration were wanting, would not deny the incomprehenſible attraction of the magnet? Philoſophy, like fanaticiſm, has its prejudices, and has often rejected as impoſſibilities what have afterwards been confirmed by experience. But ſo ſtrongly does the reſpectability of its advocates claim a favourable opinion as to the real exiſtence of the virtues aſcribed to the divining rod, that, though it ſeems impoſſible wholly to admit their teſtimony, it ſeems equally ſo wholly to reject it.

The faculty of ſubterraneous diſcovery has been referred to the theory of effluvia, or to the corpuſcular philoſophy, for explanation; but it ſeems only to have been hypothetically referred to an hypotheſis. For, in the firſt place, although the aſſerted effects of the rod have been copiouſly deſcribed, a definition of its *modus agendi*, where it will act, has been wanting, nor have we been told what particular conſtitutional defects have in moſt caſes prevented its acting at all; and ſecondly, the theory of the corpuſcular philoſophy, though perhaps it may be impoſſible wholly to reject it, has never been completely admitted. Rebeira permitted perſons to ſee him uſe the rod, but would diſcover no more; and neither Cookworthy nor Pryce has ſaid whether, as the practiſer in the divining art approaches a ſpot under which ſprings or metals lie hid, he feels any internal ſenſations: but Thouvenel has more completely provoked doubt, by aſſerting that internal ſenſations, nearly approaching to morbid affections, are

are felt, at the ſame time that an external motion is communicated to the rod. Theſe ſingular emotions, none of which were obſerved to take place, when he was above ſtagnant waters were followed by head-ache, fatigue of body, debility of mind, and other ſymptoms of nervous irritation. The dry ſtate of the atmoſphere, alſo favourable to electric experiments, was obſerved to render him more active and lively in his prognoſtics; but a full meal evidently diminiſhed the capacity; and an inflammatory fever, which confined him a fortnight to his bed, deranged or deſtroyed the miraculous power for the ſpace of three months. From theſe circumſtances it ſhould ſeem that its action is dependent on ſome peculiar nervous ſenſibility; that our faith or our imagination ſhould be prepoſſeſſed in its favour, according to Pryce; and that much depends on an harmonious diſtribution of the animal ſpirits, devoid of anxiety or reaſoning reſpecting the event: but that a ſtate of doubt is an obſtruction to its operation. Theſe, perhaps, may be the principal difficulties in uſing the divining rod; but we are aſſured by Cookworthy and Pryce, that, regarding theſe and other eſſentials in its uſe, a rod may be found adapted to the peculiar ſyſtem of every perſon.

Difficult, however, as is the admiſſion of belief in the aſſerted virtue of the divining rod, and little as it has been underſtood by thoſe who have moſt ably eſpouſed its cauſe, it may not be amiſs juſt to trace the outlines of that theory to which it has been by them referred for explanation, that of the corpuſcular philoſophy, which is a mode of accounting for the phænomena of nature by the motion, figure, reſt, poſition, &c. of the corpuſcules or minute particles of matter. Boyle ſums up the chief principles of this hypotheſis in the following particulars:—1ſt, That there is but one catholic or univerſal matter, which is an extended, impenetrable, and diviſible ſubſtance, common to all bodies and capable of all forms. 2d, That this matter, in order to form the vaſt variety of natural bodies, muſt have motion in ſome or all of its aſſignable parts; and that this motion was given to matter by the Creator of all things, and has all manner of directions and tendencies. 3d, Matter muſt alſo be actually divided into parts, and each of theſe primitive particles, fragments, or atoms of matter, muſt have its proper magnitude or ſize, as alſo its peculiar figure or ſhape. 4th, It is ſuppoſed that theſe differently ſized and ſhaped particles may have different orders and poſitions, whereof great variety may ariſe in the compoſition of bodies. (*Encyclopædia Britannica.*) Pryce, in his *Mineralogia Cornubienſis*, gives the following

account of the mode in which these corpuscules or minute *impenetrable* and *divisible* particles of matter act through the medium of the human body or nerves, or by the assistance of the animal spirits, upon the divining rod. "The corpuscules, it is said, that rise from the minerals, entering the rod, determine it to bow down, in order to render it parallel to the vertical lines which the effluvia describe in their rise. In effect, the mineralogical particles seem to be emitted from the earth: now the virgula, being of a light porous wood, gives an easy passage to those particles, which are very fine and subtle: the effluvia, then, driven forwards by those that follow them, and pressed at the same time by the atmosphere incumbent on them, are forced to enter the little interstices between the fibres of the wood, and by that effort they oblige it to incline or dip down perpendicularly, to become parallel to those little columns which the vapours form in their rise." If this jargon, this fabric of unintelligible conclusions, raised upon the slender foundation of *pre-supposition*, be not sufficiently absurd, I beg leave to refer to page 114 of Pryce's work, where he attempts an elucidation of the corpuscular theory.

If an advocate for this theory, as applied for solving the cause of the operation of the divining rod, were to be asked why hazel rods, and branches of other trees said to be attracted by metals, are not attracted by them in their natural growth; and why, consequently, they do not grow with their top declining towards the earth, I feel at a loss to conceive what would be the answer. Would he say that the *vis inertiæ* of matter is not sufficiently powerful to overcome the living principle of the tree? or would he not say that the human body is an excellent conductor of those minute particles or corpuscules, which, according to Hartley, are perpetually flying off from all bodies, for ever seeking new combinations, and of the same catholic matter forming an infinite variety of modifications throughout the universe? Some conclusion, equally satisfactory and philosophical, might be expected from the hypothetical advocates of this theory; and as, in all probability, this theory cannot be established by ocular demonstration, or by any means be made manifest to our senses, it seems as if it were better to acknowledge, if really there be any virtue in the rod, that, as in the instances of the magnetical influence and the electric fluid, it is one of those mysterious effects of the mysterious laws by which nature is governed, inscrutable to human wit, and indefinable by human investigation.

LIII. *Messrs.*

LIII. *Meſſrs.* COLLARD *and* FRASER'S *Proceſs for preparing the Weld Yellow*.*

THERE is not to be found, either in the vegetable or mineral kingdoms, any other ſubſtance which yields ſo elegant a yellow colour as the *weld*, or, as it is written by ſome, *would*, or dyer's weed. The weld is of the *reſedian* tribe, and is cultivated with care in Kent, Herefordſhire, and many other parts of the kingdom. The principal conſumers are dyers, calico-printers, and colour-makers. The plants are dried by the growers, tied up in parcels weighing from 30 to 50 pounds each, and are ſold, to uſe the language of the trade, at ſo much a bundle.

This is a very injudicious practice; for it is the ſmall ſeeds of the plant only which afford the colouring matter, a great portion of which are ſhaken out in the package, and even in moving the bundles from one place to another. Beſides, the plant altogether occupies ſo much room, that the carriage of the uſeleſs ſtalks for a hundred miles, by land, amounts to more than five per cent. upon the article; whereas the ſeeds in a quantity occupying a ſpace of ſix feet ſquare would by no means fill a half peck meaſure.

The weld yellow is a water-colour, principally uſed by paper-hanging manufacturers for elegant work. An oil colour has never been prepared from the weld. A preparation of weld yellow in oil would be a valuable acquiſition; for the patent oil colour, made from a very old *recipe*, by fuſing the oxide of lead with the muriate of ammonia in the proportion of about one pound of the former to three ounces of the latter, appears as vile as brick-duſt when compared to the weld yellow.

The weld yellow made in London is ſold in hard lumps, and muſt be ground before it is fit for uſe. Now it is well known that every colour ſuffers, in ſome degree, by that operation. By the following proceſs the moſt beautiful weld yellow may be prepared, which will fall into a fine powder, and will want no grinding.

Take of pure carbonate of lime (fine waſhed whiting) any given quantity, *e. g.* let it be four pounds; put it into a copper boiler, and add to it four pounds of ſoft water: put a fire under the copper and raiſe it to a boiling heat, and keep ſtirring with a deal ſtick till the whiting be completely divided, and forms with the water a conſiſtence quite ſmooth. Then

* Communicated by Meſſrs. Collard and Fraſer.

add

add for each pound of whiting three ounces of alum previouſly pulverized tolerably fine. The alum muſt be added gradually, and the operator ſhould keep ſtirring with his deal ſtick during the adminiſtration; for a double decompoſition is effected, accompanied with efferveſcence, and carbonic acid is diſcharged. Thus, if the alum were not adminiſtered gradually, the boiler would overflow with the violence of the efferveſcence; and, if the whiting were not well divided previous to the introduction of the alum, the diſtribution amongſt the whiting would be unequal, and the colour would be injured. When the alum is all introduced, and the efferveſcence has ceaſed, the baſis is properly prepared. The fire may be then drawn, and it may remain for any length of time without injury, till the other materials are ready. Having thus prepared the baſis, take the welds, place them, with their roots uppermoſt, in another copper boiler, pour in ſoft water enough to cover every part containing ſeed, and let them boil not more than fifteen minutes: then take them out, place them, with their roots uppermoſt, in a tub to catch the liquor which runs from them, and paſs the liquor in the copper, with what runs from the welds in the tub, through a flannel filter, to intercept the ſeeds and fæcula; and thus the colouring matter is prepared.

It is impoſſible to ſay what quantity of welds ſhould be employed to any given quantity of whiting, for ſome bundles will contain three times as much ſeed as others. It is well, however, to know, that if too much colouring matter be prepared, it may be kept in an earthen or deal veſſel for many weeks, without ſuſtaining any injury.

Having filtered a ſufficient quantity of the weld liquor, put a fire under the boiler containing the baſis, and add the weld liquor till the colour be obtained. When ſufficient colouring matter is added to the baſis, the fire ſhould be raiſed to a boiling heat, and the work is finiſhed. In order to be ſatisfied when the greateſt ſtrength of colour is obtained, for there is a *ne plus ultra*, take a little out on chalk, which will abſorb the moiſture inſtantly; when it may be laid on paper with a bruſh, and viewed perfectly dry in a few minutes.

The contents of the furnace ſhould be then put into a deal or earthen veſſel to precipitate. The next day the liquor may be poured off, and the colour may be placed on large pieces of chalk, which in a few hours will abſorb the moiſture, and it will then be fit for uſe or ſale.

The liquor poured off from the colour may, with the addition of water, be uſed again, and the old welds may be boiled a ſecond time, and taken out previous to the addition of freſh welds, ſo that no colouring matter will be loſt.

In the preceding proceſs, the greateſt care ſhould be taken that no iron be ſuffered to come in contact with the colour; for the gallic acid or aſtringent principle, which eminently abounds in this vegetable, will inſtantly diſſolve iron, and the ſmalleſt particle of that metal is fatal to the delicacy of the weld yellow.

LIV. *Experiments and Obſervations on certain Stony and Metalline Subſtances which at different Times are ſaid to have fallen on the Earth; alſo on various Kinds of Native Iron.* By EDWARD HOWARD, *Eſq. F.R.S.*

[Continued from p. 224.]

Examination of the Stone from Sienna.

THE external coating of this ſtone appeared to have the ſame characters as that of the ſtone from Benares.

The pyrites, although certainly preſent, were not cryſtallized in ſuch groups as in the preceding ſtone; nor could they be ſeparated by mechanical means.

The attractable metal was eaſily ſeparated by the magnet; but $8\frac{1}{2}$ grains only were collected. I treated them with nitric acid and ammonia, as in the preceding caſe. Nearly one grain of earthy matter was inſoluble; the weight was therefore reduced to rather leſs than eight grains. The oxide of iron, precipitated by ammonia, weighed eight grains; and the ſaline liquor gave abundant indications of nickel. As eight grains of this oxide of iron contain nearly ſix of metal, the quantity of nickel in the bare eight grains may be eſtimated between one and two grains. Some globular bodies were extracted, but too few to analyſe.

Since the pyrites could not be ſeparated, I collected 150 grains of the ſtone, freed from iron by the magnet, and as exempt as poſſible from globular bodies. Theſe 150 grains I firſt digeſted with muriatic acid, that the pyrites might be decompoſed, and every thing taken up which could be diſſolved by that menſtruum. A very decided diſengagement of ſulphureted hydrogen gas was occaſioned. When the acid could produce no further action, I collected the undiſſolved matter on a filter, and boiled it with the moſt concentrate nitric acid, in hopes of being able to convert the ſulphur, previouſly liberated, into ſulphuric acid: but my endeavours were fruitleſs; for, upon the addition of nitrate of barytes to the nitric ſolution, rendered previouſly tranſparent, a very inſignificant

inſignificant quantity of ſulphate of barytes was obtained. The ſurplus of barytic nitrate was removed by ſulphate of potaſh. I next completely edulcorated the maſs which remained inſoluble after the action of the muriatic and nitric acids; and, adding the water of edulcoration to the muriatic and nitric liquors, evaporated the whole for ſilica. I then ſubmitted the maſs, undiſſolved by the acids and the water, to the treatment with potaſh, muriatic acid, and evaporation, which was, in the firſt inſtance, applied to the ſtone from Benares. The firſt precipitation was, as in that analyſis, alſo effected with carbonate of potaſh; but, inſtead of endeavouring immediately to extract alumina, I ignited the precipitate, that the alumina or ſilica remaining might be rendered inſoluble. After the ignition, I ſeparated the oxide of iron with very concentrate muriatic acid; and the earths, which were left perfectly white, I heated with potaſh, until they were again capable of being taken up by the ſame acid. The ſolution ſo made was ſlowly evaporated; and, as very nearly every thing was depoſited during the evaporation, I conclude all was ſilica. The proportions reſulting from this ſingle analyſis, without the weight of ſulphur contained in the pyrites irregularly diſſeminated through the whole, were,

Silica - - - - -	70
Magneſia - - - -	34
Oxide of iron - - - -	52
Oxide of nickel - - -	3
	159

Examination of the Stone from Yorkſhire.

The mechanical ſeparation of the ſubſtances in this ſtone being as difficult as in the preceding caſe, I was neceſſarily ſatisfied with ſubmitting it to the ſame treatment. I collected, however, 34 grains of malleable particles; which, by the proceſs already more than once mentioned, left four grains of earthy matter; and, by yielding 37½ of oxide of iron, indicated about four grains of nickel.

150 grains of the earthy part of the ſtone were, by analyſis, reſolved into,

Silica - - - - -	75
Magneſia - - - -	37
Oxide of iron - - - -	48
Oxide of nickel - - -	2
	162

Examination

Examination of the Stone from Bohemia.

The probability of never being able to obtain another ſpecimen of the very remarkable fragment of this ſubſtance, did not allow me to treſpaſs more on the liberality of Mr. Greville, than to detach a ſmall portion. I found it of ſimilar compoſition to that of the three preceding ſtones; and the count de Bournon has already ſhown the proportionate quantity of the attractable metal to be very conſiderable. $16\frac{1}{2}$ grains left $2\frac{1}{2}$ of extraneous earthy matter; and yielded, by the treatment with nitric acid and ammonia, $17\frac{1}{2}$ grains of oxide of iron. This would ſeem to induce an eſtimation of $1\frac{1}{2}$ of nickel in 14 grains, or about nine per cent.

55 grains of the earthy part of the ſtone, by the analytical treatment of the two former, afforded,

Silica	25
Magneſia	$9\frac{1}{2}$
Oxide of iron	$23\frac{1}{2}$
Oxide of nickel	$1\frac{1}{2}$
	$59\frac{1}{2}$

The unuſual increaſe of weight in the reſult of the three laſt analyſes, notwithſtanding the entire loſs of the ſulphur in the pyrites, is obviouſly owing to the metallic ſtate of the iron combined with the ſulphur, as was ſhown in a former inſtance.

I have now concluded the chemical examination of theſe four extraordinary ſubſtances. It unfortunately differs from the analyſis made by the French academicians, of the ſtone preſented to them by the abbé Bachelay, as well as from that made by profeſſor Barthold of the ſtone of Enſiſheim. It is at variance with that of the academicians, inaſmuch as they found neither magneſia nor nickel. It differs from that of Mr. Barthold, as he did not find nickel, but diſcovered ſome lime, with 17 per cent. of alumina. With regard to theſe differences, I have to ſubmit to the chemical world, whether magneſia might not have eluded the action of an acid, when the aggregation of the integrant parts of the ſtone was not deſtroyed by treatment with potaſh. As to the exiſtence of alumina, I do not abſolutely deny it; yet I muſt obſerve, that the whole of the earth which ſeemed to have any reſemblance, however ſmall, to alumina, was at moſt 3 per cent., and there ſeems good reaſon to conſider it as ſilica. Reſpecting the exiſtence of lime in the ſtone of Enſiſheim, I muſt appeal to profeſſor Barthold, whether, ſuppoſing lime a conſtituent part, ſulphate of lime ſhould not have been formed,

as well as ſulphate of magneſia, when ſulphuric acid was generated by igniting the earths and pyrites. And, as to the proportion of alumina in the ſame ſtone, I would aſk, at leaſt, whether it would have been ſo conſiderable if the ſolutions formed by acids, after the treatment with potaſh, had been evaporated to the requiſite dryneſs: not to obſerve, that no mention is made of any examination of the properties of the earth called alumina. In the proportion of magneſia I have the ſatisfaction to find my analyſis correſpond very nearly with that of profeſſor Barthold; and, if what he conſidered alumina were ſuppoſed ſilica, the ſtone preſented to the French academy, the ſtone of Enſiſheim, and the four I have examined, would agree very nearly in ſiliceous proportions. With reſpect to the nickel, I am confident it would have been found in all, had the metallic particles been ſeparately examined. But, whatever be theſe variations, the mineralogical deſcription of the French academicians, of Mr. Barthold, and of the count de Bournon, all exhibit a ſtriking conformity of character, common to each of theſe ſtones; and I doubt not but the ſimilarity of component parts, eſpecially of the malleable alloy, together with the near approach of the conſtituent proportions of the earths contained in each of the four ſtones, the immediate ſubject of this paper, will eſtabliſh very ſtrong evidence in favour of the aſſertion, that they have fallen on our globe. They have been found at places very remote from each other, and at periods alſo ſufficiently diſtant. The mineralogiſts who have examined them agree that they have no reſemblance to mineral ſubſtances properly ſo called, nor have they been deſcribed by mineralogical authors. I would further urge the authenticity of accounts of fallen ſtones, and the ſimilarity of circumſtances attendant on ſuch phænomena; but to the impartial it would be ſuperfluous, and, to thoſe who diſbelieve whatever they cannot explain, it would be fruitleſs. Attempts to reconcile occurrences of this nature with known principles of philoſophy, it is true, are already abundant; but (as the earl of Briſtol has well expreſſed) they leave us a choice of difficulties equally perplexing. It is, however, remarkable that doctor Chladni, who ſeems to have indulged in theſe ſpeculations with moſt ſucceſs, ſhould have connected the deſcent of fallen ſtones with meteors; and that, in the narrative of Mr. Williams, the deſcent of the ſtones near Benares ſhould have been immediately accompanied with a meteor.

No luminous appearance having been perceived during the day on which the ſtone fell in Yorkſhire, it muſt be admitted, rather militates againſt the idea that theſe ſtones are the ſubſtances

ſubſtances which produce or convey the light of a meteor, or that a meteor muſt neceſſarily accompany them *. Yet the ſtones from Sienna fell amidſt what was imagined lightning, but what might in reality have been a meteor. Stones were alſo found after the meteor ſeen in Gaſcony, in July 1790. And Mr. Falconet, in the memoir I have already quoted, relates, that the ſtone which was adored as the mother of the gods, was a *bœtilia*; and that it fell at the feet of the poet Pindar, enveloped in a ball of fire. He alſo obſerves, that all the *bœtilia* had the ſame origin.

I ought not, perhaps, to ſuppreſs, that in endeavouring to form an artificial black coating on the interior ſurface of one of the ſtones from Benares, by ſending over it the electrical charge of about 37 ſquare feet of glaſs, it was obſerved to become luminous, in the dark, for nearly a quarter of an hour; and that the track of the electrical fluid was rendered black. I by no means wiſh to lay any ſtreſs upon this circumſtance; for I am well aware that many ſubſtances become luminous by electricity.

But, ſhould it ever be diſcovered that fallen ſtones are actually the bodies of meteors, it would not appear ſo problematical, that ſuch maſſes as theſe ſtones are ſometimes repreſented, do not penetrate further into the earth: for meteors move more in a horizontal than in a perpendicular direction; and we are as abſolutely unacquainted with the force which impels the meteor, as with the origin of the fallen ſtone.

Before I cloſe this ſubject, I may be particularly expected to notice the meteor which, a few months ago, traverſed the county of Suffolk. It was ſaid that part of it fell near Saint Edmundſbury, and even that it ſet fire to a cottage in that vicinity. It appeared, from inquiries made on the ſpot, that ſomething, ſeemingly from the meteor, was, with a degree of reaſon, believed to have fallen in the adjacent meadows; but the time of the combuſtion of the houſe did not correſpond with the moment of the meteor's tranſition. A phænomenon much more worthy of attention has ſince been deſcribed in the Philoſophical Magazine. On the night of the 5th of April 1800, a body wholly luminous was ſeen, in America, to move with prodigious velocity. Its apparent ſize was that of a large houſe, 70 feet long; and its elevation above the ſurface of the earth about 200 yards. The light produced effects little ſhort of ſun-beams; and a conſiderable degree of heat was felt by thoſe who ſaw it, but no electric ſenſation. Immediately after it diſappeared in the north-

* In the account of the ſtone which fell in Portugal, no mention is made either of a meteor or lightning.

weſt,

weſt, a violent ruſhing noiſe was heard, as if the phænomenon were bearing down the foreſt before it; and, in a few ſeconds after, there was a tremendous craſh, cauſing a very ſenſible earthquake. Search being afterwards made in the place where the burning body fell, every vegetable was found burnt, or greatly ſcorched, and a conſiderable portion of the ſurface of the earth broken up. We have to lament that the authors of this account did not ſearch deeper than the ſurface of the ground. Such an immenſe body, though moving in a horizontal direction, could not but be buried to a conſiderable depth. Should it have been more than the ſemblance of a body of a peculiar nature, the lapſe of ages may perhaps effect what has now been neglected; and its magnitude and ſolitary ſituation become the aſtoniſhment of future philoſophers.

This leads me to ſpeak of the ſolitary maſs of what has been called native iron, which was diſcovered in South America, and has been deſcribed by Don Rubin de Celis. Its weight was about 15 tons. The ſame author mentions another inſulated maſs of the ſame nature. The whole account is exceedingly intereſting; but, being already publiſhed in the Philoſophical Tranſactions for the year 1788, it needs not be here repeated.

Mr. Prouſt has ſhown the maſs particularly deſcribed, not to be wholly iron, but a mixture of nickel and iron. The truſtees of the Britiſh Muſæum, who are in poſſeſſion of ſome fragments of this maſs, ſent to the Royal Society by Don Rubin de Celis, have done me the honour to permit me to examine them; and I have great ſatisfaction in agreeing with a chemiſt ſo juſtly celebrated as Mr. Prouſt.

[To be continued]

LV. *A Diſſertation on the Reflection and Refraction of Light from Vapours, Fogs, Miſts, &c.; with an Account of ſome curious Phænomena proceeding from thoſe Cauſes, ſeen in Ireland in the Years* 1796, 1797, *and* 1801. *By* WILLIAM BEAUFORD, *A.M.*

To Mr. Tilloch.

SIR, Dublin. Aug. 8, 1802.

IF the following philoſophic inveſtigation of ſome curious phænomena be adapted to your excellent publication, the Philoſophical Magazine, it is at your ſervice.

Of all the phænomena exhibited by nature in her various operations, there are none more curious and extraordinary than

than thoſe repreſented by the reflection and refraction of light from fogs and vapours ariſing from the ſea, lakes, and moraſſes, replete with marine and vegetable ſalts. For ſuch vapours, by means of the ſaid ſalts, form various poliſhed ſurfaces, which reflect and refract the light of the ſun, and even the moon, in various directions; thereby not only diſtorting but multiplying the images of objects repreſented to them in a moſt ſurpriſing manner; forming not only images of caſtles, palaces, and other buildings, in various ſtyles of architecture, but the moſt beautiful landſcapes, ſpacious woods, groves, orchards, meadows, with companies of men and women, with herds of cattle, walking, ſtanding, lying, &c., and all painted with ſuch an admirable mixture of light and ſhade that it is impoſſible to form an adequate conception of the picture without ſeeing: not any ſcenery repreſented by the *camera obſcura* can be more beautiful, or more like faithful repreſentations of nature.

Though theſe curious and elegant phænomena are not peculiar to any age or country, they are more frequently ſeen on the ſea-coaſts; and though in ſome reſpects common in ſuch ſituations, they have hitherto been ſo little noticed by the intelligent part of mankind as to be ſcarce known to exiſt. The only ones which ſeem at preſent to have attracted the attention of the curious, are thoſe frequently, during the ſummer ſeaſon, ſeen on the ſouthern coaſts of Italy, near the antient city of Rhegium; and even to this attention they were directed by the fiſhermen and country peaſants, who in their native tongue call them *fata morgana*, or *dama fata morgana* *. They are, however, frequently noticed by the Engliſh, Erſe, and Iriſh peaſants, fiſhermen, and mariners; and denominated in the languages of the two latter *feadhreagh mairethmhe*, or ſea fairies, and *duna feadhreagh*, fairy caſtles. The Erſe fiſhermen among the weſtern iſles of Scotland frequently ſee repreſented on barren heaths and naked rocks beautiful fields, woods, and caſtles, with numerous flocks and herds grazing, and multitudes of people of both ſexes in various attitudes and occupations. Theſe, as they know no ſuch objects really exiſt, they conſtantly attribute to inchantment, or the fairies. They are alſo frequently ſeen on the coaſts of Norway, Ireland, and Greenland †. On the eaſtern and weſtern coaſts of South America, even on the higheſt ſummit of the Andes, the *fata morgana* is met with. Alſo far out at ſea, in the midſt of the Atlantic and Pacific oceans, the adventurous mariner ſometimes obſerves them;

* Swinburne's Travels. † Crantz's Hiſtory of Greenland.

and though well known under the name of *fog banks*, yet has their appearance been ſo impoſing as to illude the niceſt ſcrutiny, and to promiſe refreſhments to the fatigued and ſea-worn mariner which he could not obtain. The moſt antient account of theſe aërial caſtles and iſlands which has been tranſmitted to us, is the repreſentation of a beautiful iſland ſituated nearly in the middle of the Atlantic ocean, between the coaſts of Ireland and Newfoundland, firſt obſerved by ſome Daniſh and Iriſh fiſhermen about the year 900, and from that period to the commencement of the 14th century frequently by the Anglo-Saxon, Engliſh, and French fiſhermen and mariners *.

But, as this iſland could never be approached, it was called the *inchanted iſland*, and ſuppoſed by the maritime inhabitants of Scotland, Ireland, France, and Spain, to be the country of departed ſpirits, and conſequently denominated in Erſe *Flath Innis*, or the Noble Iſland; in Iriſh *Hy Braſil*, or the Country of Spirits; by the Anglo-Saxons, *Icockane*, or the Country in the Waves; and by the French and Spaniards, who ſuppoſed it to conſiſt of two diſtinct iſlands, *Braſil* and *Aſſmanda*, or the Iſlands of Ghoſts. And ſo much perſuaded were geographers of the 16th and 17th centuries of their real exiſtence, that they have place in all or moſt of the maps of the Atlantic in thoſe periods; and even in the laſt century De l'Iſle, the French geographer, in his maps has placed them as follows: Braſil, lat. 51° north, long. 1° eaſt of Ferror; and Aſſmunda, lat. 46° 30′ north, long. 356° eaſt of Ferror. Even ſo late as about the year 1750 an Engliſh ſhip, returning from Newfoundland, near lat. 50° north diſcovered an iſland not heretofore known, which not only appeared fertile, but covered with verdant fields and ſhady woods, among which cattle were ſeen to graze; and only the appearance of a violent ſurge hindered the captain and crew from landing, according to their deſire †. So well convinced, however, were they of its real exiſtence, that, on arriving at London, ſhips were ordered out to complete the diſcovery: but no iſland could be found, nor has any land been diſcovered in that track from that time to the preſent. Commodore Byron, in his Voyage round the World, mentions a fog bank in a high ſouthern latitude, which appeared like an iſland, with capes and mountains, deceiving the moſt experienced ſeamen on board for ſome time.

From theſe evidences of the frequent appearance of the *fata morgana*, I ſhall proceed to deſcribe ſome ſeen near

* Iceland. Ann. Ortelius in Theſauro Geo. Antient Sax. Poem.

† Swinburne's Travels.

the

the town of Youghal, in the county of Cork, Ireland, in the years 1796, 1797, and 1801, according to the annexed views (see Plate VIII.) drawn on the spot by a young lady, one among numbers of the spectators. The first was seen on the 21st of October 1796, about four o'clock in the afternoon, the sun clear: it appeared on a hill, on the county of Waterford side of the river, and seemed a walled town with a round tower, and a church with a spire; the houses perfect, and the windows distinct. Behind the houses appeared the mast of a ship, and in the front a single tree, near which was a cow grazing; whilst the Waterford hills appeared distinctly behind. In the space of about half an hour the spire and round tower became covered with domes, and the octagonal building, or rather round tower, became a broken turret. Soon after this change, all the houses became ruins, and their fragments seemed scattered in the field near the walls: the whole in about an hour disappeared, and the hill on which it stood sunk to the level of the real field. The hill and trees appeared of a bright green, the houses and towers of a clear brown, with their roofs blue.

On the 9th of March 1797, another similar phænomenon was observed by the same person, in company with several others, about eight o'clock in the morning, on the sea, south-east of the town of Youghal. It had the appearance of a walled town situated on a hill. On one side were houses in ruins, and the ruins of a castle which seemed to fall into the sea. In the middle were two towers broken, on one of which was a flag flying, with houses in ruins between them and the castle. On the south were walls and a round tower with windows, which appeared broken in the middle. The hill on which the whole scene was placed was green and brown, and the buildings purple and brown, clear and brilliant, much resembling a transparent painting. The wall which surrounded the town was of a darker brown, with great holes as if made by cannon shot. The sea was calm and serene, and the whole together formed a charming view; but it is not known how long the scene continued, as the party was obliged to leave the strand before it vanished. What increased the beauty of the scene was the fineness of the morning, and the ships which appeared to pass behind it.

In June 1801, about five o'clock on a fine morning, all the coast opposite the river of Youghal, on the Waterford side, was covered with a dense vapour: that on the right next the sea had the representation of an alpine country; the distant scarpy mountains seemed covered with snow, whilst the foreground, of a brown colour, resembled woods and a cultivated

country. Soon the ſnow was ſeen to roll down the ſides of the mountains into the valleys beneath, and left the gray rocks of the mountains naked and ſharp. As the ſun increaſed in power, the vapour vaniſhed. On the left, the river and adjacent country were alſo covered with a vapour, but of quite different appearance from the former. The country ſeemed laid out in lawns and improvements, in which were ſituated three gentlemen's ſeats; the houſes well defined, the windows and doors diſtinct; ſome of the windows appeared open, and braſs knockers were ſeen on the doors. From the houſes were beautiful ſhrubberies bordered with white Chineſe paling; behind the ſhrubberies were foreſts of pines; and diſtant mountains, in fine perſpective, cloſed the ſcene. Before the houſes in the lawns were clumps of fine foreſt trees. In about half an hour two of the houſes vaniſhed, and the clumps in front diſappeared, and in their place a fine oak ſprang up, which was the laſt that quitted the ſcene. The ſun becoming powerful, the vapour was rareſied, and the entire magic diſappeared.

The two former of the exhibitions of the *fata morgana* were evidently cauſed by the reflection of ſome of the buildings and other parts of the town of Youghal in a denſe vapour or fog ſtrongly illuminated by the ſun. But in order to have an adequate idea of the nature of the phænomenon, let AG (fig. 1.) be a fog bank or denſe vapour, whoſe ſurface next the ſun is uneven, and formed of a variety of planes capable of reflecting light, as AB, BC, CD, DE, EF, and FG. Let O be a houſe and tree. Now, by the laws of optics, if a ſpectator be ſo ſituated, as at I, that the reflective rays proceeding from the incident ones OG, OF, &c. meet the eye of the ſpectator at I, the image of the houſe and tree at O will be multiplied into the town *vr*, in which, if the ſurface DE is cylindrical and ſomewhat irregular at the top, the image of the houſe will be transformed into a tower, and the roof into a ſpire, with the chimney a flag. Alſo, if any of the other planes be imperfect, the images reflected therefrom will be imperfect, and the houſes appear in ruins. If the ſpectator moves from I to L, and during that time the air ſhould change any of the ſurfaces, the repreſentation will be ſomewhat changed; the image of O, from the plane DE, will become a tower with a dome, and the whole will appear as at *xy*. As the wind changes the form of the fog, or the poſition of the ſun or clouds alters the lights, the entire repreſentation will diſappear, or ſuffer conſiderable changes: on which account none of thoſe aërial exhibitions continue any length of time, and always in calm weather and a clear

ſky, if the picture is brilliant; for, though thoſe fog banks often appear in dark or cloudy weather, the reflection is imperfect, and repreſents only confuſed images of rocks, mountains, and capes. Though diſtant objects are reflected, thoſe immediately under or behind will be refracted. Thus in fig. 2. if a vapour reſts upon an horizontal plane AB, the point B will be refracted to *a*, when the plane will repreſent a hill to a ſpectator at I. The ſcenery may alſo be repreſented by refraction only; for, if the fog or vapour ſhould contain two ſmooth ſurfaces oppoſite to each other, in the manner of a double concave lens, objects will be ſeen refracted, though much diminiſhed in apparent magnitude; and if one or both of the concave ſurfaces ſhould be compoſed of different inclined planes, a ſingle object will be variouſly multiplied and transformed. Thus let AB (fig. 3.) repreſent a vapour, whoſe ſurfaces are concave and tranſparent, but of different faces, as CD, DE, and EF, the object M will be ſeen by a ſpectator at G ſmall and at a great diſtance beyond M, and multiplied as at PQ. And this caſe was exhibited from a bog vapour in the county of Kildare in the year 1787. About eleven o'clock in the morning, the ſun ſhining clear, a hill appeared, about a mile diſtant, covered with trees and houſes, where it was known there was only a plain field; the phænomenon being cauſed by a houſe and garden refracted through a denſe and facetwiſe concave vapour ariſing from the bog.

Theſe phænomena are alſo frequently cauſed by the light refracted through the cryſtalline parts of the vapour, without any of the adjacent objects being either refracted or reflected. For the vapour, being formed into different parts, the light refracted through them cauſes the confuſed appearance of ruins, houſes, woods, lawns, &c. in the ſame manner as a board covered in an irregular manner with black and white ſpots mixed with lines, will at a certain diſtance reſemble a landſcape with woods, ruins, houſes, trees, caſtles, &c., and under ſuch impoſing forms as to appear real repreſentations. Of this ſpecies of the *fata morgana* ſeem to be thoſe ſeen at Youghal in 1801 before ſpoken of: but in whatever manner the repreſentations from vapours and fogs are formed, the weather muſt be calm and ſerene, otherwiſe the vapours will be broken and diſperſed by the wind.

LVI. *An Eſſay on the Colours obtained from the metallic Oxides, and fixed by Fuſion on different vitreous Bodies. By* ALEXANDER BROGNIART, *Director of the National Manufactory of Porcelain at Sevres, Engineer of Mines, &c.**

THE art of employing metallic oxides for colouring by fuſion different vitreous matters, is of very great antiquity: every body knows that the antients manufactured coloured glaſs and enamel, and that this art was practiſed in particular by the Egyptians, the firſt people who in this manner imitated precious ſtones.

The practice of this art in modern times has been carried to a high degree of perfection: but the theory has been neglected; it is almoſt the only one of the chemical arts in which no attempt has yet been made to apply the new principles of that ſcience.

The very numerous works which treat on the method of preparing and applying vitrifiable metallic colours, either contain no theory, and conſequently no general principles, or give only explanations founded on hypotheſes, often ridiculous, which formerly compoſed the theory of chemiſtry.

One of the beſt, becauſe it is the work of an enlightened artiſt, is the *Traité de la Peintre en Email de Montamy*. The archives of the national manufacture of Sevres contain alſo ſimple and excellent proceſſes for the fabrication of colours. The authors of them are Meſſrs. Bailly, Fonteliau, and Montigny; but they are mere deſcriptions, without any obſervation which can conduct to general principles.

The other works, ſuch as that of Kunckel, and the manuſcripts of Hellot in the poſſeſſion of the manufactory of Sevres, and the two *Encyclopædias*, preſent only an undigeſted aſſemblage, a compilation without choice and without reaſoning, of a multitude of proceſſes collected from all quarters. When ſome knowledge of the art has been obtained, it is eaſier to invent a proceſs than to diſcover among that variety of recipes the one which ought to be preferred.

It has been remarked, that one of the moſt certain ſigns of the progreſs made by a ſcience towards perfection is the poſſibility it leaves of collecting the facts that compoſe it into one ſyſtem, from which general principles might be deduced: it is at this epoch alone that it deſerves the name of ſcience; and it is to an expoſition of its principles thus generalized

* From the *Journal des Mines*, No. 67.

that

that the appellation, more impoſing than correct, of philoſophy of ſcience has been given.

The arts, which are often rather a branch of a ſcience than the mere application of one of its parts, preſent facts equally ſuſceptible of being united in a ſyſtematic form: to carry them ſoon to perfection, it is ſufficient that they are practiſed by men habituated to diſtinguiſh relations, and to deduce conſequences from them.

The learned, who by more elevated ſpeculations are removed from the practice of the arts, perceive the principles of them more readily: they can apply their reſearches in a more direct manner to the advancement of them; and their progreſs, guided by reaſoning, will be more certain, more direct, and more rapid.

I obſerved that the art of preparing and uſing vitrifiable colours was ſuſceptible of the improvement I have pointed out, and that the facts of which it is compoſed begin to be ſufficiently numerous and correct to be exhibited in a general manner. I have thought that an accurate knowledge of theſe facts, and an expoſition of the principles by which they are connected, and which muſt naturally lead to an explanation of a great many of them, might be intereſting to chemiſts, who, employed in more general and more important reſearches, cannot be acquainted with all the details of an art which is exceedingly complex.

I was deſirous alſo to give chemiſts an exact knowledge of the principles of this art, in order that they may be enabled to determine with more certainty what novelty there may really be in the proceſſes ſubmitted to their opinion.

In a word, I have thought it might be of utility to the arts, and that it was the duty of the national manufactory of Sevres to make known the pretended ſecret of the compoſition of thoſe porcelain colours which are unalterable in the fire. It is well known that theſe colours were preſented to he Inſtitute, in the year 6, by a porcelain manufacturer juſtly eſteemed for the beauty of the works which come from his manufactory. I ſhould not have ventured to publiſh this ſecret had it been intruſted to me; but when it is known, I hope I ſhall not be ſuſpected of having in the leaſt abuſed the confidence repoſed in me.

From what has been ſaid it may be readily ſeen that my object is not to give a detailed account of the exact compoſition of all the vitrifiable colours; ſuch a labour cannot be the ſubject of a ſingle memoir.

It is well known that all vitrifiable colours have for their

baſis metallic oxides; but all the metallic oxides are not proper for this purpoſe: beſides, as they are not vitrifiable by themſelves, they can ſcarcely ever be employed alone.

Highly volatile oxides, and thoſe which adhere little to the great quantity of oxygen they contain, either cannot be employed in any manner, as the oxide of mercury and that of arſenic, or are employed only as agents. The colour they preſent cannot be depended on, ſince they muſt loſe it in the ſlighteſt heat by loſing a part of their oxygen: ſuch are the puce-coloured and red oxides of lead, the yellow oxide of gold, &c.

Oxides in which the proportions of oxygen are ſuſceptible of varying with too much facility are rarely employed: the oxide of iron, though black, is never employed for that colour; and the green oxide of copper is, under many circumſtances, very uncertain.

I have ſaid that oxides alone are not ſuſceptible of fuſion: however, as they are deſtined to be applied in thin ſtrata on vitrifiable ſubſtances, they may be attached to them by a violent heat. But, except the oxides of lead and biſmuth, they would give only dull colours. The violent heat, often neceſſary to fix them, would change or totally deſtroy the colours. A flux then is added to all metallic oxides.

This flux is glaſs, lead, and ſilex; glaſs of borax, or a mixture of both.

Its general effect is, to give ſplendour to the colours after their fuſion; to fix them on the article which is painted, by promoting more or leſs the ſoftening of its ſurface; to envelop the metallic oxides, and to preſerve their colour by ſheltering them from the contact of the air: in a word, to facilitate the fuſion of the colour at a low temperature not capable of deſtroying it.

The obſervation which proves the latter uſe of fluxes is taken from the delicate colours, ſuch as carmine obtained from gold: theſe colours require much more flux than others. Metallic oxides are employed ſometimes directly, and merely mixed with their flux, without being previouſly fuſed with it: theſe colours are thoſe which a ſtrong heat, or heat too often repeated, would alter. It may be readily conceived that a ſtronger and longer continued heat is neceſſary to fuſe a crucible full of coloured glaſs, than a ſtratum of colour not the tenth part of a millimetre in thickneſs.

I ſhall return to this ſubject when I come to ſpeak of the reds obtained from gold.

In many circumſtances, oxides are fuſed previouſly with their

their flux, and afterwards ground. In ſpeaking of colours in particular, I ſhall point out thoſe which experience this kind of fuſion.

Theſe general principles are ſo ſimple that it is not neceſſary to enlarge on them further.

I ſhall ſpeak here only of the application of metallic colours to vitreous bodies or to vitreous ſurfaces.

Theſe bodies may be divided into three claſſes, very diſtinct by the nature of the ſubſtances which compoſe them, the effects produced on them by the colours, and the changes they experience. Theſe claſſes are:

1ſt, Enamel. ſoft porcelain, and all cruſts, enamels, or glaſs, that contain lead in a notable quantity.

2d, Hard porcelain, or porcelain which has a cruſt of feld-ſpar.

3d, Glaſs in the compoſition of which no lead enters, ſuch as common window-glaſs.

I ſhall here examine in ſucceſſion the principles of the compoſition of theſe colours, and the general phænomena they exhibit on theſe three kinds of bodies.

Colours for painting in enamel are thoſe moſt antiently known: the recipes found in the works I have already mentioned, all relate to theſe colours.

It is well known that enamel is glaſs rendered opake by the oxide of tin, and exceedingly fuſible by the oxide of lead. It is the oxide of lead, in particular, contained in it that gives it properties very different from thoſe of the other excipients of metallic colours. Thus all glaſs and glazing that contain lead will participate in the properties of enamel; and what we ſhall ſay of one may be applied to the reſt with very trifling differences.

Such are the white and tranſparent glazing of ſtone ware, and the glazing of porcelain called *ſoft glazing*.

This porcelain, which was the firſt made in France, and particularly at Sevres, where it was a long time manufactured almoſt excluſively, has for its baſe a vitreous fritt rendered almoſt opake, and ſuſceptible of being worked with clay, and is glazed with an exceedingly diaphanous glaſs, into the compoſition of which there enters a great deal of lead.

The colours employed in it are thoſe which ſerve for painting in enamel: conſequently whatever changes theſe colours experience on enamel they muſt experience on this kind of porcelain, ſince the cauſes of this change, which we ſhall mention hereafter, are the ſame.

Enamel or ſoft porcelain colours require leſs flux than

others,

others, becauſe the glaſs on which they are applied becomes ſufficiently ſoft to be penetrated by them.

This flux may be either glaſs of lead and pure ſilex, called *rocaille*, or the ſame glaſs mixed with borax.

Montamy aſſerts that glaſs of lead ought to be baniſhed from among the enamel fluxes; and he employs only borax. He then diſlutes his colours in a volatile oil.

On the other hand, the painters of the manufactory of Sevres employ only colours without borax, becauſe they dilute them in gum; and borax does not dilute well in that ſubſtance. I have found that both methods are equally good; and it is certain that Montamy was wrong to exclude fluxes of lead, ſince they are daily employed without any inconvenience, and as they even render the application of colours eaſier.

I have ſaid that in the baking of theſe colours, the cruſt, ſoftened by the fire, ſuffers itſelf to be eaſily penetrated by them. This is the firſt cauſe of the change which they experience. By mixing with the cruſt they become weaker, and the firſt heat changes a figure which appeared to be finiſhed into a very light ſketch.

The oxide of lead which the cruſt contains is a ſecond but much more powerful cauſe of the conſiderable changes which colours experience. The deſtructive action which that metal exerciſes chiefly on iron reds is ſingularly remarkable. I ſhall ſoon give an account of ſome experiments which prove it in a very evident manner.

It has been already ſeen, that the two principal cauſes of the changes which colours on enamel and ſoft porcelain are ſuſceptible of experiencing do not depend in any manner on the compoſition of theſe colours, but on the nature of the glaſs to which they are applied. When it is ſaid that the colours of porcelain change in a conſiderable degree, it ought to be added that it is thoſe of ſoft porcelain; a kind almoſt neglected.

It follows from what has been ſaid, that painting on ſoft porcelain has need of being ſeveral times retouched, and of ſeveral heats, in order that it may be carried to the neceſſary degree of ſtrength. Theſe paintings have always a certain faintneſs; but they are conſtantly more brilliant, and they never are attended with the inconvenience of detaching themſelves in ſcales.

Hard porcelain, according to the diviſion which I have eſtabliſhed, is the ſecond ſort of excipient of metallic colours. This porcelain, as is well known, has for its baſe a very white clay called *kaolin*, mixed with a ſiliceous and calcareous flux, and

and for its covering feld-ſpar fuſed without an atom of lead.

This porcelain, which is that of Saxony, is much newer at Sevres than the ſoft porcelain. The colours applied to it are of two kinds: the firſt, deſtined to repreſent different objects, are baked in a heat very inferior to that neceſſary for baking porcelain. They are exceedingly numerous and varied.

The others, deſtined to be fuſed in the ſame heat as that which bakes porcelain, lay themſelves flat, and are much leſs numerous.

The colours of painting are made nearly like thoſe deſtined for ſoft porcelain; they only contain more flux. Their flux is compoſed of glaſs of lead called *rocaille*, and borax. I am not yet acquainted with any work which treats on the compoſition, uſe, and effects of theſe colours; ſo that it has no where been printed except in one, which might be diſpenſed with, that theſe colours ſcarcely undergo any change in the fire, while it has been often written and ſaid, that the colours for painting in enamel change conſiderably.

When porcelain is expoſed to heat in order to bake the colours, the covering of feld-ſpar dilates itſelf and opens its pores, but does not become ſoft: as the colours do not penetrate it, they experience none of thoſe changes which they undergo on ſoft porcelain. It muſt, however, be ſaid that they loſe a little of their intenſity by acquiring that tranſparency which is given to them by fuſion.

When common articles are manufactured, the retouching may be omitted; but it is neceſſary to give to a painting all the effect that can be deſired: in a word, this retouching does not diſtinguiſh painting on porcelain from any other kind of painting.

One of the greateſt inconveniences of theſe colours, eſpecially in the manufactory of Sevres, is the facility with which they ſcale off when expoſed ſeveral times in the fire.

This inconvenience is obſerved more at Sevres than any where elſe, becauſe it depends on the ſolidity and infuſibility of the porcelain manufactured in that eſtabliſhment. But theſe are qualities which make it much longer reſiſt alternations of heat and cold, and which give to its paſte a more ſtriking whiteneſs. Paris porcelain, on the other hand, being more vitreous, more tranſparent, and bluer, often cracks when boiling liquors are put into it.

To remedy this defect without altering the quality of the paſte, I was of opinion that the cruſt only ought to be ſoftened by introducing into it more ſiliceous or calcareous flux, according to the nature of the feld-ſpar. This method has ſucceeded;

ſucceeded; and for about a year paſt the colours might be expoſed two or three times to the fire without ſcaling, if not overcharged with flux, and if not laid on too thick. It has been remarked that ſoda and potaſh introduced into the colours make them ſcale; they are therefore never uſed as fluxes. It is found that theſe alkalies, by becoming volatilized, abandon the colour, which when alone cannot form an adheſion with the cruſt.

I have ſaid that colours are alſo prepared, which, being laid on flat, are deſtined to be fuſed in a furnace for baking porcelain. Theſe colours are not numerous, becauſe few metallic oxides can ſtand ſuch a heat without being volatilized and diſcoloured. Their flux is ſand or feld-ſpar: as they incorporate with the cruſt they are more brilliant, and never become ſcaly.

The third ſort of excipient of vitrifiable metallic colours is glaſs without lead.

The application of theſe colours to glaſs conſtitutes painting on glaſs; an art very much practiſed ſome centuries ago, and which was ſuppoſed to be loſt becauſe out of faſhion; but it has too direct a dependence on painting in enamel and porcelain to be entirely loſt. Beſides, a deſcription of it may be found in a very great number of works.

[To be continued.]

LVII. *On Painting.* *By Mr.* E. Dayes, *Painter.*

Essay IV.

On Grace.

> From vulgar bounds with brave diſorder part,
> And ſnatch a grace beyond the reach of art. Pope.

Gracefulness, which may be termed the beauty of motion, is an idea not very different from beauty, and almoſt inſeparable from it. It is an idea belonging to poſture and motion, and will be found to conſiſt in an eaſe unaccompanied with reſtraint or difficulty; as at all times the moſt eaſy will be the moſt graceful: it is generally attended with a ſlight inflection of the body, unbroken, that is, not interrupted with ſudden angles; and, in ſitting figures, with an eaſe approaching to languor.

Propriety of action is a thing of the higheſt importance to the figure painter, whether he works in large or ſmall.

Expreſſion does not merely apply to the face, as many ſuppoſe,

poſe, but to the general action and character of each figure, that it be appropriate to the perſon deſcribed; as the ſtate and carriage of public officers, heroes, &c., the clowniſh and ſimple attitudes of peaſants; and on this being well performed depends the very ſoul of a good picture.

Much of the merit of Raphael ariſes from the ſuperior degree of dignity obſervable in his apoſtles and other great characters: on the contrary, the excellence of Parmegiano reſults from the elegant turns he gave his female figures.

As the arts are no longer exotic, we ſhall find thoſe graces rendered familiar in the works of Reynolds, Mortimer, &c.*

The whole power of man depends on two motions, flection and extenſion: thoſe may be again ſubdivided into four; the ſimple, as in walking, eating, and drinking; the active, as in carrying, pulling, thruſting or puſhing, and climbing; the violent, ariſing from fright, rage, deſpair, or any other ſudden emotion: the fourth ſort, which may be conſidered as a ſort of paſſive action, reſults from diſquiet of mind, as love, hatred, ſorrow, joy, &c.: the effect of which is chiefly ſhown in the extremities, as the face, hands, and feet.

It will be generally found that violent paſſions of the mind are accompanied with actions more or leſs angular than the beautiful or paſſive: as in a man in the act of ſtriking with a club or ſtick, the upper and fore-arm will form a right angle; again, in a figure frightened, the arms from being thrown up will form an angle with the body; in figures puſhing or pulling, the effect will be the ſame: on the contrary, elegant or graceful figures ſhake off thoſe violences, and fall into attitudes that ſhow a gentle inflection of line.

We ſhall find, a ſtanding figure to be graceful muſt reſt on one leg, and the face incline to the hip it reſts on, as in the Venus de Medicis, and others remarkable for taſte and beauty.

As beauty loves variety, we ſhall generally obſerve, if the figure is preſented in front, the head will appear rather inclined to the ſide. (See Plate VI.)

* If I have cautiouſly forborne to ſpeak of the works of living artiſts, it is not from thinking light of them, but from a nobler motive. In the limits I have preſcribed to myſelf I could not do juſtice to the merits of ſo many and able profeſſors as at preſent adorn the nation. The prints from the works of Britiſh artiſts are circulated over the civilized part of the world, and copied as ſoon as they appear on the continent. Such being the fact, whatever the ignorant may aſſert to the contrary, thoſe who with to encourage hiſtorical painting in this country ſhould aim at cheriſhing ſuch a ſpirit as would eventually operate to induce buyers not to give more for works of foreign artiſts than they would for works of equal merit of the Britiſh ſchool.

That

That beautiful undulating line of grace will alſo be found in the moſt agreeable ſitting figures.

Notwithſtanding what may have been ſaid about "ſmoothneſs, delicacy," &c., yet we ſhall find on inquiry much of the grace and beauty of the painter and ſculptor ariſes from what Hogarth has termed the "line of beauty," and which was not only practiſed but recommended by M. Angelo, as may be ſeen in the book on painting, by Jo. Paul Lomatius, tranſlated by Richard Haydocke in 1598: "ſo that his meaning is (M. Angelo), that it ſhould reſemble the form of the letter S placed right, or elſe turned the wrong way, as ∽; becauſe then it hath his beauty."

The graceful parts of the antique ſtatues poſſeſs that ſweeping line of grace: it may be ſeen too in the figures of Raphael, Parmegiano, &c.; and among the more modern artiſts, as Reynolds, Mortimer, Cipriani, &c.

Three things contribute to the beauty of the Venus de Medicis; its line of grace running unbroken through the whole figure, its form, and the variety and contraſt of the parts, as the head with the cheſt, and the arms and legs with each other.

Thoſe who ſuppoſe this character of line affects the general attitude only, are wrong; it will be found to conſtitute the general form of the muſcle, if taken detached, and viewed from its fleſhy belly to the tendinous part: this, with its interſecting angle, gives much of that variety of character obſervable in human nature. We ſometimes ſee in overcharged figures the convex lines raiſed ſo much beyond the limits of nature, that the power of re-entering them again is loſt, and the whole form appears heavy and incumbered. This fault ſometimes attaches to M. Angelo, but by no means in the extreme aſſerted by Mengs, who, ſpeaking of that artiſt, ſays, "who ſeeking to be always great, was always vulgar." Such language argues great want of either ſenſe or ſincerity: by the way, his favourite Raphael is not entirely free from the charge of heavineſs, in his women in particular.

The Hercules Farneſe of Glicon is a fine example of the well-ordered raiſing and interſecting of the muſcles in a figure poſſeſſing the appearance of great paſſive ſtrength: but few ſimilar examples will occur to the artiſt in the courſe of his practice.

That figure forms the extreme point one way, and the Apollo Belvidere (or Pytheus), the other, for beauty; beyond which it is impoſſible to travel without being abſurd: the mean between thoſe two is the fighting Gladiator (as it is called),

called), and which may be conſidered as the moſt natural, the others more pure. Thoſe obſervations muſt be conſidered as applying to the general character of the figures, and not to the parts; the gladiator being in ſtrong action, the appearance of the muſcles is altered; thoſe in action being ſhort, and of courſe rounded more than thoſe in repoſe.

Grace is of ſo delicate a nature that it cannot exiſt in the preſence of whatever is rude, vulgar, or exceſſive: it charms, captivates, and overcomes, by its beneficence: its motions are eaſy, moderate, and lovely, and it partakes more of the humble than arrogant: it is ſeen in the Apollo accompanied with dignity, in the Venus of Medicis with modeſty, and in the Antinoüs in a more human and leſs elevated degree.

Parmegiano poſſeſſed in a high degree the faſcinating power of grace; Corregio felt it in a certain degree; and the females of Albano are diſtinguiſhed by it. Reynolds's portraits abound with it, and it will be ſought for with ſucceſs in many of the noble monuments of Britiſh art.

Raphael underſtood the grace of motion; but his dry gothic manner of execution did not aſſociate with it: he wanted that ſweet mellow pencil neceſſary to beauty.

If painting were an imitation of nature merely, as many ſuppoſe, it would follow of courſe that it ſhould be inferior to it, as the efficient muſt always be ſuperior to the effect: but this ſubſiſts conditionally: as in the power of light, and its oppoſite darkneſs, nature has the advantage: but even light is ſubjugated to the powers of art, as in our paintings on glaſs, of which the eaſt window of New College, Oxford, ſtands a moſt glorious example, and may be juſtly entitled the firſt work of the kind in the world*; but in the article of beauty, and the juſt power of combination, art has greatly the advantage.

Matter is imperfect, and all that is left us is the will to chooſe; and happy, thrice happy, is that artiſt who knows the value of what is good, and in the early purſuit of his ſtudies learns to diſtinguiſh what is more or leſs great and amiable, thereby fixing his deſires on things worthy.

By attentively conſidering the works of the great, from the Greeks to the preſent time, we ſhall find they fixed their attention on the moſt noble part of the art, and purſued the ſtudy of it with unremitting ardour: on the contrary, inferior beings became attached to mediocrity, and believed in it

* Many ignorantly ſuppoſe the art of painting on glaſs is loſt: the fact is, if we are to judge from the ſpecimens produced in the preſent age, it never was found till now.

centred

centred all art; while the little grovelling ſpirit became inchanted with whatever was minute and trifling, miſtaking them for principal things.

If the works of renowned artiſts are to be uſed to ſtimulate, we ſhall alſo derive advantage from thoſe who have ſunk from the great to the trifling and uſeleſs, nay, even to the ugly, and from it to the falſe and chimerical, by conſidering them as ſo many rocks and quickſands to ſteer clear of.

A well-ordered picture becomes a leſſon of polite education, by which our manners are amended: on the contrary, dirty ragged ruffians, accompanied with traſh and common-place ſtuff, are not only beneath the dignity of painting, but may corrupt young minds: nay, may not rudeneſs be juſtified by a reference to pictures exhibiting clowniſh and hoggiſh examples, or people the moſt baſe and corrupt of humanity?

It is a poor apology, becauſe a picture is well painted, that it ſhould be hung up in our apartment, when in the arrangement it may violate ſenſe, and in the choice decency; or the people ſuch as one would by no means ſuffer to approach our perſons: and yet nothing is more common. Such efforts may pleaſe the ignorant, but will not call the attention of learned men and philoſophers, with whom ſuch men can only rank as mechanics, and beings without diſcrimination.

What man of taſte ever ſaw a fine picture by Teniers without feeling the heart-ache that ſo much fine colour, *chiaro-ſcuro*, and execution, ſhould be beſtowed on worthleſs objects? Moſt of the Dutch pictures operate as a libel on their country, by the monſters of humanity introduced in them. In a note to the Life of Hogarth, by lord Orford, (*Vide* Anecdotes of Painters), is the following juſt remark on the Dutch artiſts:—"When they attempt humour, it is by making a drunkard vomit; they take evacuations for jokes; and, when they make us ſick, think they make us laugh. A boor hugging a frightful frow, is a frequent incident in the works of Teniers."

We might juſtly conclude that artiſt mad, or ſilly, who, *leaving in his purſuit the grand or beautiful of nature*, ſhould collect for his pictures objects *diſguſting* and *unſightly*: and yet this is frequently the caſe; which ariſes from want of early good inſtruction, and from being led aſtray by people writing on the arts, who are perfectly unqualified for ſo arduous a taſk.

Some have even attempted to ſeparate the picturesque from the beautiful, as if that which did not poſſeſs beauty could be worthy of painting. By the word picturesque the artiſt underſtands the irregular, but ever accompanied with a beautiful

tiful choice, and it ſtands in oppoſition to the ſimple or grand; it does not apply to objects "rough and irregular," or ſuch as are deformed, aged, and ugly.

We muſt give up our underſtanding if we call a landſcape fine which repreſents dirty rugged grounds, ſcrubby buſhes, poor ſcraggy and ill-formed trees, ſhapeleſs lumps of antiquity, and muddy pools; peopled with gipſies and vagabonds, dirty beggars clothed with rags, their heads decorated with filthy drapery, ſkins like tanned leather, and their employ diſguſting; and theſe accompanied with poor and old cattle, or naſty ſwine on filthy dunghills. And ſhall thoſe be the objects with which we are to decorate, or rather deform, our apartments? Such a choice argues a taſte as depraved, as if a man were to prefer the horrid ſqueaking of a cart-wheel, to the fineſt ſolo on an organ.

Such objects, if introduced in pictures, can only be ſparingly uſed, to ſet off and give value to beauty, as a foil, but ſhould never appear as principals.

If a man producing ſuch pictures is to be diſtinguiſhed by the noble appellation of a *genius*, we ſhould find ſome other term to beſtow on ſuch artiſts as Raphael, Corregio, Titian, Rubens, Reynolds, &c. &c. &c.; and in landſcape, Pouſſin, Wilſon, Claude, Barret, &c. One thing we are ſure of, that is, that there is no mention of ſuch renowned wrong-heads among the Greeks *.

It muſt not be underſtood that we reject the paſtoral as unworthy; on the contrary, it is highly intereſting, and, when accompanied with ſentiment and a judicious ſelection, (as in ſome of Gainſborough's fine compoſitions,) does honour to the arts. Equally intereſting, though in a leſs degree meritorious, ſtands the ſimple repreſenter of nature; he acquires a new character as a topographer, provided he attach fidelity to his repreſentations.

Under the article *invention* we ſhall again have occaſion to ſpeak of the picturesque; we ſhall then reſume our ſubject.

Two parts of the body that contribute much to the grace of the figure are an eaſy turned head and neck (ſee Pl. VII.), and a graceful and elegant hand and arm. M. Angelo, Raphael, &c. afford many examples of men; and Parmegiano, Guido, Reynolds, Mortimer, &c. of women. To produce

* The rage for what is termed the *picturesque*, we ſhould ſay the *deformed*, in the modern and miſunderſtood ſenſe of the word, is carried ſo far, that I ſhould not be ſurpriſed to hear that groups of filthy gipſies were paid to wander about gentlemen's grounds for what ſome might term their *picturesque effect*. One advantage would reſult from it to their employers, that is, they might indulge their ſmell as well as taſte.

this effect of grace, it is requiſite that the head ſhould not preſent the ſame view as the cheſt, and that the hand and arm ſhould not come on a line, but that each ſhould contraſt the other by an oppoſing turn. For examples, ſee the drawings (Plate VI. and VII.)

Of the feet, our knowledge of beautiful form can only be acquired through the medium of the antique, or fine pictures, being now deformed by the uſe of ſhoes. Suffice it to obſerve, the three foremoſt toes ought to be the longeſt; the ſmall ones cloſe, and turning out; and the great one a little ſeparated, more or leſs in proportion to the action of the foot.

Beauty appears to delight in the irregular or picturesque, while the grand will ever be accompanied with the regular and ſimple.

LVIII. *Notice reſpecting the Manners and Habits common to the Shark and Pilot-Fiſh. By* C. Geoffroy, *Profeſſor in the Muſæum of Natural Hiſtory*.*

It has been aſſerted that the ſharks have ſubject to their empire a very ſmall fiſh of the ſpecies of the *gadus*; that the latter precedes his maſter during his voyages, points out to him thoſe places of the ſea moſt abundant in fiſh, diſcovers to him the traces of the prey he is fondeſt of; and that, out of gratitude for ſuch ſignal ſervices, the ſhark, notwithſtanding his voracity, lives in good intelligence with a companion ſo uſeful to him. Naturaliſts, always on their guard againſt the exaggerations of travellers, and not being able to conceive the motives of ſuch an aſſociation, have doubted the truth of theſe facts. It will, however, be ſeen that they were wrong: the obſervations even which I have been able to make are accompanied with circumſtances which perhaps never occurred with ſo many details to any one but myſelf.

In the month of May 1798 I was on board the Alceſte frigate between cape Bon and the iſland of Malta. The ſea was tranquil, and the paſſengers were much fatigued with the long duration of the calm, when their attention was attracted by a ſhark which they ſaw advancing towards the veſſel. It was preceded by its pilots, which kept at a pretty regular diſtance from each other, and from the ſhark. The two pilots directed their courſe towards the poop of the veſſel, inſpected it twice from one end to the other, and, after having ſatisfied themſelves that there was nothing which they could turn to

* From the *Bulletin des Sciences.*

their

their advantage, reſumed their former route. During the various movements which they made, the ſhark never loſt ſight of them, or rather followed them as exactly as if he had been dragged by them.

He had no ſooner been deſcried than one of the ſailors got ready a large hook, which he baited with lard; but the ſhark and his companions had already proceeded to the diſtance of 20 or 25 millimetres before the ſailor had made all his preparations: he, however, threw the piece of lard into the ſea at a venture. The noiſe occaſioned by its fall was heard at a conſiderable diſtance. The travellers were aſtoniſhed, and ſtopped. The two pilots then detached themſelves, and went to explore at the poop of the veſſel. The ſhark during their abſence ſported in a thouſand ways at the ſurface of the water; turned himſelf on his back, then on his belly, and dived to a greater depth, but always re-appeared at the ſame place. When the two pilots came to the poop of the Alceſte they paſſed cloſe to the lard, and no ſooner obſerved it than they returned to the ſhark with a greater velocity than they advanced to it. When they reached it, the latter continued his courſe. The pilots then ſwimming one on his right and the other on his left, made every effort to get before him. Scarcely had they done ſo when they ſuddenly returned, and then went back a ſecond time to the poop of the veſſel. They were followed by the ſhark, who was enabled by the ſagacity of his companions to perceive the prey deſtined for him. It has been ſaid that the ſhark is endowed with a very delicate ſenſe of ſmelling. I paid a great deal of attention to what took place on his approaching the lard. It appeared to me that he did not diſcover it till the moment it was pointed out to him by his guides; it was then only that he began to ſwim with greater velocity, or rather made a jump to ſeize it. He detached a portion of it without being hooked; but at the ſecond attempt the hook penetrated the left lip, by which means he was hoiſted on board.

It was not till the end of two hours, during which I was employed in anatomizing the ſhark, that I began to regret I had not obſerved more accurately the ſpecies which had devoted themſelves ſo readily to the ſervice of this voracious fiſh. I was aſſured that ſome of them might be eaſily procured, as it was certain they had not quitted the neighbourhood of the veſſel; and a few moments after I was preſented with an individual, which I found to belong to the pilot or *Janfre des marins*, and the *gaſteroſteus ductor* of the naturaliſts.

It would be, no doubt, curious to inquire what intereſt can induce animals ſo different in their organization, their ſize,

and habits, to form a ſort of aſſociation. Does the pilot-fiſh feed on the dung of the ſhark? as C. Boſe thinks; and has it impoſed on itſelf the painful duties of domeſticity to find protection and ſafety in the neighbourhood of ſo voracious an animal?

LIX. *Experiments on Charcoal expoſed to high Degrees of Heat in cloſe Veſſels. By* DAVID MUSHET, *Eſq. of the Calder Iron Works* *.

IN a former communication I ſhowed that in Stourbridge clay crucibles, made perfectly air-tight, a proportion of charcoal diſappeared much greater than could poſſibly combine with the iron in contact with it. This I attributed to cauſes not yet aſcertained, but worthy of inveſtigation. In many experiments with diamonds, particularly thoſe of D'Arcet and Macquer, it ſeemed that they diſappeared when incloſed in balls of porcelain, and where it was ſuppoſed no air was preſent to promote combuſtion. The facts eſtabliſhed by thoſe eminent chemiſts appeared thus at variance with thoſe principles by which the nature and properties of the diamond and other combuſtible ſubſtances were explained: nor have I yet learned if a ſatisfactory explanation of them has been given.

Having prepared a parcel of ſmall Stourbridge clay crucibles nearly of the ſame ſize, I performed the following experiments with different proportions of charcoal.

Exp. I. In one of the crucibles was incloſed five grains of well dried charcoal: the crucible was yet moiſt. The mouth was afterwards brought together and accurately ſhut. When well dried in a temperature from 70° to 80° of Fahrenheit, it was placed in an annealing fire, and gradually heated till of a bright red colour. It was then placed in the aſſay furnace, and a conſiderable degree of heat excited for the ſpace of 35 minutes. When withdrawn, and cold, it was carefully examined, and found free from cracks. It was then cautiouſly broken, but exhibited no marks of charcoal: one vitrid ſpot only was obſervable upon the bottom, which I ſuppoſed to ariſe from the fuſion of the alkaline reſiduum after the deſtruction of the wood.

Exp. II. In this the crucible contained ten grains of charcoal. It was treated in the ſame manner, only expoſed to a more violent and continued heat. When cold, no cracks ap-

* Communicated by the Author.

peared,

peared, and the interior of the vessel presented a solitary spot of vitrid matter larger than that of No. I. by the additional quantity of charcoal employed.

Exp. III. was performed with 20 grains of charcoal, and a similar result with the former two was obtained.

Exp. IV. contained 30 grains of charcoal. This also disappeared.

Exp. V. was performed with 40 grains, when a few minute flakes of charcoal remained.

Exp. VI. was made with - - grs. 60
After the usual treatment and exposure, I found that a considerable portion of the charcoal now remained, which I found to weigh - - 35

Not taken up 25

The first inference I was led to make from these experiments was, that the charcoal was consumed by the air included in the crucible when it was introduced. This seemed plausible enough where only five or ten grains were employed, and a considerable space left unoccupied; but in the two last experiments the charcoal was of such bulk as nearly to fill the crucible.

Exp. VII. To determine this, I took a piece of well burnt charcoal wood of 20 grains. This was introduced into a crucible, and shut up in a similar manner with the former. It was placed, after the same train of drying and preparation, in the assay furnace, where for two hours it received the utmost heat that the pot was deemed capable of standing. When cold, I found the crucible very entire, and inclosing the piece of charcoal, apparently of its former dimensions and shape; but, on closer examination, I found the angles completely rounded, and the surface covered with very minute transparent globules of salt. The blackness of the charcoal had deepened into a degree of lustre and richness surpassing any thing of the kind I had ever witnessed. The mass now weighed 17 grains.

From the result of this experiment I inferred that the quantity of included air was not adequate to explain the disappearance of the charcoal powder of the former experiments. I was now led to conceive that it might be materially assisted by the expulsion of a certain quantity of water baked in the clay, which, by a well known affinity, might be decomposed on the charcoal at a high temperature, and carbonic acid gas consequently formed.

Exp. VIII. There were inclosed 20 grains of charcoal in a crucible similar to the former. After ten weeks drying, in

a temperature frequently beyond that of boiling water, the crucible was cut acrofs, and found to contain 18 grains. It appeared, therefore, neceffary to the volatilization of the charcoal that a greater heat be urged.

Exp. IX. The fame quantity of charcoal was employed, and fubjected to the fame treatment. The crucible was then placed in the annealing furnace, and broken, as it came from thence, after cooling. The charcoal had difappeared, and, in place of the vitrid matter formerly obtained, a few flakes of alkaline falt were found on the bottom. The heat of the annealing fire did not exceed 30° of Wedgewood. The crucible was weighed before put in and when taken from the annealing fire, and was found to have loft $\frac{1}{9}$th part of its weight, which was fuppofed to be water.

It appears pretty conclufive, from the two laft experiments, that a high heat is neceffary to expel the laft portions of water; and that, as in Exp. VIII., the charcoal nearly remained entire where a temperature confiderably beyond that of boiling water was applied: it was in confequence of the expulfion of this water that the charcoal had difappeared.

This conclufion will eafily explain the evaporation of diamonds in balls of moift clay, wherein the fame circumftances would take place as at prefent. It will particularly explain an experiment of Macquer's, wherein he inclofed charcoal in baked and unbaked crucibles of clay. In the former, where no moifture was prefent, the charcoal remained unchanged; but in the latter it difappeared, and the afhes were found vitrid, as in thefe experiments. This was attributed to certain fhrinkages or cracks, which might take place with green clay, and which afterwards became invifible in cooling.

It is probable, however, that charcoal of wood may furnifh part of the means of its own difappearance by a confiderable deoxidation at a high temperature, and leave its refiduum in a much purer ftate than formerly. The following experiment will prove this.

Exp. X. I took 20 grains of beautiful black charcoal collected from experiments where it had been expofed to heats of 165° Wedgewood. Thefe were inclofed in an unbaked pot, which was fet afide to dry. In three months the crucible was found to weigh - - grs. 8313

It was then placed in the annealing fire, and weighed at a bright red heat - - - 7403

Loft equal to $\frac{1}{9\frac{1}{10}}$th part 910

The

The crucible was then placed in a high heat for two hours, and withdrawn quite entire. When cold, I found a fine impalpable powder of charcoal of a deep velvet black which weighed 12 grains. The treatment in this experiment was every way similar to the former (No. III.), yet only eight grains of charcoal were here missing.

LX. *Observations and Reflections on Storms, and some other Phænomena of the Atmosphere. In a Letter from Professor* WATERHOUSE *to Dr.* MITCHILL, *dated Cambridge, Massachusetts, March* 20, 1802.

"DEAR SIR,

YOUR letter of the 8th instant, requesting information of the precise time the late wide-spreading storm commenced at this place, came to my hands evening before last. I hasten to gratify you as far as I am able.

"Sunday, the 21st of February, the day preceding the storm here, was remarkably calm and pleasant. The smoke ascended from the chimneys in a straight column. The thermometer at noon was 47. Neither hygrometer nor barometer indicated, at that period, any disposition of change in the atmosphere. As late as half past ten at night, the sky was clear and star-light. At about two hours and a half after this, viz. one o'clock in the morning of the 22d, the snow-storm began. My information comes from an intelligent market-man, who set out from his own house for Cambridge at midnight. Excepting for a few hours on Wednesday, 24th, we saw not the sun for nine days. It was the longest if not severest snow-storm I ever knew.

"I here send you an abstract from the official meteorological observations * kept in this university by Mr. Webber,

* *Some Meteorological Observations.*

	Barom.	*Ther.*	*Hygr.*	*Wind.*	*The Sky.*
Feb. 21, 9 P. M.	29 80	27	56	N. W. weak.	Few clouds.
22, 7 A. M.	29 60	25	84	N. very strong.	Wholly cloudy.
2 P. M.	29 30	17	83	Do.	Do.
9 P. M.	29 24	12	83	Do.	Do.
23, 7 A. M.	29 61	1	80	N. W. very strong.	Mostly cloudy.

"A severe snow-storm continued through the whole of the 22d. The falling snow was very thick; the wind very strong, and somewhat to the E. of N. but appearing to me, by the college vane, to be nearer to the N. than the N. E. It was noted N.

"The scale of the barometer is French measure, but is here reduced to the English or common scale, and correction made for the effect of variation in temperature. The instruments are placed without a north chamber window."

professor of natural philosophy. You will observe it commences at 9 o'clock in the evening of the 21st. I did not think it necessary to add any thing respecting the magnetic needle.

"I can readily conceive several good purposes may be answered by this inquiry. I have therefore written to Kennebec and to Halifax, and requested my correspondent at the last place to extend his inquiries to Newfoundland. I hope you will extend yours to Pensacola, and even to Jamaica. The severity of the storm was from north-north-east; that is, north, two points to the east, being, you know, what the ancients termed *aquilo*. These observations will probably strengthen the opinion prevalent in this quarter, that all our severe north-east storms begin first, in point of time, in the south-west. Franklin was first led to notice this, on being prevented, by a stormy sky, from observing an eclipse of the moon at Philadelphia, when at Boston, 400 miles north-east of that city, the hemisphere was sufficiently clear for that purpose.

"The ancients had some strange notions of the local origin of winds. They speak of them as something different from air in motion, and as if the matter of the winds were a hot vapour or exhalation from caverns in the earth, where Æolus kept them in chains, only when his churlish majesty chose to let them loose, like so many bull-dogs, to scare Juno, and worry her favourites. This fable, however, is, like almost all those of the ancients, pregnant with wisdom. Lord Bacon himself has laboured to teach mankind how to make Æolus subservient to Juno, and so did Franklin. The transition from winds to rain and snow is easy and natural.

"It has always impressed me with something bordering on wonder, that, during the six-and-twenty centuries wherein the memory and learning of mankind have been exercised, there has not been found one secretary of nature sufficiently instructed to give us a complete history of the ascent of vapours from the ocean, their suspension in the air, the formation of clouds, of snow, and of the descent of rain, with an entire and connected chain of causes. Des Cartes, Nieuwentyt, Dr. Halley, Hunter, and some few others, have amused the world with their theories on this subject; but which of them is unincumbered with difficulties? What facts we have in this sublime part of nature, are mere fragments widely scattered. The phænomena in these lofty regions of the air have been rather terrific objects to purblind superstition, than instructive appearances to calm philosophy.

"The never-ceasing circulation of water between the ocean and the dry ground has been contemplated, from the earliest ages,

ages, with grateful admiration; but, not being an object of ſight, has been ranked among the inexplicable works of Deity. The clouds diſpenſing refreſhing ſhowers of rain on the dry and thirſty ground; the flow of rivers, with their long train of beneficial conſequences, could hardly eſcape the notice of any thinking being in every age of the world. We accordingly find the ſupply of water frequently mentioned in the OLDEST BOOK we have, among the moſt wonderful as well as valuable of Heaven's bleſſings.

"Seeing the earth annually covered with a rich and beautiful carpet of vegetables, and theſe aſtoniſhingly variegated, and gradually developing 'from ſeed-time to harveſt-time,' muſt have led thoſe of ancient days to recognize the proximate cauſes, the warmth of the ſun, and the moiſture from the clouds; and theſe again to an acquaintance with that perpetual circulation ſubſiſting between the ocean and the mountains, through the inſtrumentality of the atmoſphere, and by the medium of rivers to the ocean again. But the philoſophy or explanation of this vivifying phænomenon is ſpoken of as inſcrutable and paſt finding out. They did then, as we do now, carry our inveſtigations as high as we can, as in the caſe of gravitation, and beyond that principle ſay, with them, 'it is the hand of God;' an expreſſion denoting the laſt term of our analytical reſults. Unable to inveſtigate the eſſence of light and of fire, the Deity was called by the name of theſe inexplicable agents.

"In thoſe early days, when the knowledge of nature was confined to narrow limits, they, like our Indians,

'Saw God in clouds, and heard him in the winds.'

Hence they ſtyled the Deity 'the father of the rain,' and repreſented him as 'calling forth the waters of the ſea, and pouring them down according to the *vapour* thereof.' Whence we infer, they believed the water roſe in the form of *vapour* from the ocean, and that it became *freſhened* in its paſſage through the air; and it moreover appears that they were ſenſible that this proceſs was regularly and perpetually performing; for they remarked that 'although all the rivers run into the ſea, yet was the ſea not full; unto the place whence the rivers come, thither they return again.' They ſeem alſo to have known that MOUNTAINS made a part of this GRAND APPARATUS, and to have believed that it was not a fortuitous or random proceſs, but regulated, as we now find it, by weight and meaſure. May not this be inferred from that ſublime queſtion of Iſaiah—'Who hath meaſured the

the *waters* in the hollow of his hand, and weighed the *mountains* in ſcales?'

"Although they diſcerned this magnificent apparatus, and ſaw its effects, yet were they reſtrained by a religious awe from attempting its inveſtigation, becauſe ſtorms, lightning and hail, were conceived to be the precurſors of the chariot of the Deity! 'who maketh the *clouds* his chariot'—'who walketh on the wings of the *wind*'—accompanied with '*hailſtones* and *fire!*' Or, if you chooſe to have the ſpirit of theſe paſſages expreſſed in Engliſh metre—

'On cherubs, and on cherubims,
'Full royally he rode,
'And on the wings of all the winds
'Came flying all abroad.'

For this reaſon, probably, the origin and courſe of the winds, 'whence they come and whither they go,' were deemed myſterious. Hence, inſtead of inveſtigating the cauſe, their pious minds, overwhelmed with awe, ſunk into undiſcerning amazement! Under ſuch impreſſions, I ceaſe to wonder that he who wrote that ancient drama, the book of Job, puts among the moſt difficult of his queſtions that which demands an explanation of the 'balancing of the clouds.' But ſhall not we, who are happily free from the terrors of the Moſaic as well as Pagan ſyſtems, and who enjoy the encouraging *intellectual* ſcheme of Chriſtianity, which, never forgetting Deity, poſtpones every thing *corporeal* to the *primary mental cauſe* *—I ſay, ſhall not we unite our efforts to fill up that dreary blank left in ſcience by the ancients? And 'as man, who is the ſervant and interpreter of nature, can act and underſtand no further than he has, either in operation or in contemplation, obſerved of the method and order of nature †,' let us commence a patient obſervation of the ordinary and extraordinary phænomena that occur in this ſcene of wonders, the atmoſphere; and then collect thoſe fragments of knowledge, widely ſcattered through the world, on the ſame ſubject.

"Although much of the operations going forward in the atmoſphere may have ſome links that have hitherto eſcaped the moſt inquiſitive eye, and others, though ſeen, may not be fully underſtood, ſtill we ought not to be diſcouraged. Theſe detached links will one day be united, and form a part of the great chain of natural cauſes, adding ſtill ſtronger

* Harris.
† Novum Organ. Scient.

proofs

proofs of that *unity of design* which pervades the great Temple of Nature.

"Some men seem destined to observe and record naked facts; others, of a superior genius, follow after and apply them. Some future Franklin may do with these *desiderated* facts what Newton did with those collected by Kepler and Galileo, and therewith form a system which may teach us to bridle the *winds* themselves, and render them further subservient to human uses."

LXI. *An Attempt towards a Theory of the Resistance experienced by two and four-wheeled Carriages on different Kinds of Roads; and to determine the Circumstances under which the one are preferable to the other.* By NICHOLAS FUSS, *Professor of the higher Mathematics at Petersburgh, Member of the Imperial Academy of Sciences, &c.*

[Concluded from p. 266.]

FOURTH DIVISION.

On the Resistance experienced from single Obstacles.

Section 33.

AMONG these obstacles I include, as already mentioned, section 2, single excavations and elevations which here and there occur on roads, such as ridges, stones, channels, cavities, broken pavement, and bridges, &c. When such impediments frequently occur, an examination of the increase of resistance which thence arises cannot be a matter of indifference to the object of the question, and therefore I shall treat of them in particular in the present division.

I. *Roads worn into Sinuosities.*

Section 34.

Let AB, Pl. II. fig. 7. be a road of this kind where the sinuosities are pretty regular. Required the resistance which arises to four as well as two-wheeled carriages at a given point F of the road, the tangent to which, FM, forms with the direction of the road AB an angle $= \gamma$. In this case, when the road is solid, and otherwise free from inequalities, the resistance for the fore-wheels will be found by the same method as that employed section 7 and section 8 to be:

$$\tfrac{1}{2} m \lambda P \cos.\ \alpha\ (\alpha + \gamma) + (\tfrac{1}{2} P + p) \sin.\ (\alpha + \gamma)$$

And for the hind-wheels, when the angle which the tangent F′M′ forms in F with the direction of the road is expressed by δ, the resistance in this point will be:

$$\tfrac{1}{2} n \lambda P \cos.\ (\alpha + \delta) + (\tfrac{1}{2} P + p') \sin.\ (\alpha + \delta).$$

For

For the whole resistance, then, of four-wheeled carriages we shall have:

$$R = \begin{cases} \frac{1}{2} m \lambda P \cos.(\alpha+\gamma) + (\frac{1}{2}P + p) \sin.(\alpha+\gamma) \\ + \frac{1}{2} n \lambda P \cos.(\alpha+\delta) + (\frac{1}{2}P + p') \sin.(\alpha+\delta) \end{cases}$$

But for two-wheeled carriages the resistance in the same point will be found by section 10 and section 11 to be:

$$R' = m \lambda P \cos.(\alpha+\gamma) + (P + \varepsilon P + \pi) \sin.(\alpha+\gamma)$$

But the moving power here is $V = M \left(1 - \frac{g}{G}\right)^2 \cos.\gamma$.

II. *Single Excavations.*

Section 35.

For single excavations or hollows, the distance of which from each other is greater than that between the fore and hind axles, the angle will be $\delta = 0$; consequently we shall have for the resistance to four-wheeled carriages,

$$R = \begin{cases} \frac{1}{2} m \lambda P \cos.(\alpha+\gamma) + (\frac{1}{2}P + p) \sin.(\alpha+\gamma) \\ + \frac{1}{2} n \lambda P \cos.\alpha + (\frac{1}{2}P + p') \sin.\alpha \end{cases}$$

Section 36.

If such excavations occur on roads of the second and third class, fig. 8, the resistance for two and four-wheeled carriages in the above point F on the former kind of roads will be,

$$R = \begin{cases} \frac{1}{2} m \lambda P \cos.(\alpha+\gamma) + (\frac{1}{2}P + p) \sin.(\alpha+\gamma) \\ + \frac{1}{2} n \lambda P \cos.\alpha + (\frac{1}{2}P + p') \sin.\alpha \\ + (\frac{1}{2}P + p) \cos.(\alpha+\gamma) \operatorname{tang}.\varphi + (\frac{1}{2}P + p') \cos.\alpha \operatorname{t}.\downarrow \end{cases}$$

$$R' = \begin{cases} \mu \lambda P \cos.(\alpha+\gamma) + (P + \varepsilon P + \pi) \sin.(\alpha+\gamma) \\ + (P + \pi) \cos.(\alpha+\gamma) \operatorname{tang}.\omega \end{cases}$$

And for the latter kind of roads the resistance will be:

$$R = \begin{cases} \frac{1}{2} m \lambda P \cos.(\alpha+\gamma) + (\frac{1}{2}P + p) \sin.(\alpha+\gamma) \\ + \frac{1}{2} n \lambda P \cos.\alpha + (\frac{1}{2}P + p') \sin.\alpha \\ + (\frac{1}{2}P + p) \cos.(\alpha+\gamma) \sin.\beta \operatorname{tang}.\xi \\ + (\frac{1}{2}P + p') \cos.\alpha, \sin.\beta, \operatorname{tang}.\eta \end{cases}$$

$$R' = \begin{cases} \mu \lambda P \cos.(\alpha+\gamma) + (P + \varepsilon P + \pi) \sin.(\alpha+\gamma) \\ + (P + \pi) \cos.(\alpha+\gamma) \sin.\beta \operatorname{tang}.\vartheta \end{cases}$$

In regard to $\varepsilon = \frac{OH}{OI}$; in all these cases $OH = OS \operatorname{tang}.(\alpha + \varkappa)$, where $\varkappa$ denotes the angle which the pole IH makes with the inclined plane AB when the wheel is in F. If IW be drawn perpendicular and OM parallel to AB, the angle $MOI = K$ and $\sin. K = \frac{MI}{OI}$.

Example.

Section 37.

Let every thing be the same as in the example given section

tion 30. That is, let there be a single excavation in a road consisting of such dry sand; let the carriage be in F; and let the angle $\gamma = 19°$, MI = 9 inches, OI = 12 feet; in this case, sin. $\varkappa = 0{\cdot}06250$, and $\varkappa = 3° 35'$; consequently OH $= 0{\cdot}38038$, and $\varepsilon = 0{\cdot}03170$. From these data we shall have,

For four-wheeled Carriages.

$\frac{1}{2}\mu\lambda$ P cos. $(\alpha + \gamma)$	=	12·273
$\frac{1}{2}n\lambda$ P cos. α	=	9·976
$(\frac{1}{2}$ P $+ p)$ sin. $(\alpha + \gamma)$	=	267·260
$(\frac{1}{2}$ P $+ p')$ sin. α	=	49·527
$(\frac{1}{2}$ P $+ p)$ cos. $(\alpha + \gamma)$ sin. β, tang. ξ	=	115·624
$(\frac{1}{2}$ P $+ p')$ cos. α, sin. β, tang. η	=	107·112
	R =	561·772

For two-wheeled Carriages.

$\mu\lambda$ P cos. $(\alpha + \gamma)$	=	15·780
$(P + \varepsilon P + \pi)$ sin. $(\alpha + \gamma)$	=	535·317
$(P + \pi)$ cos. $(\alpha + \gamma)$ sin. β, tang. ϑ	=	208·035
	R′ =	759·132

We have here $M\left(1 - \frac{g}{G}\right)$ cos. $\gamma = 561{\cdot}772$, and $M\left(1 - \frac{g'}{G}\right)^2$ cos. $\gamma = 759{\cdot}132$; consequently $g = +1{\cdot}518$ and $g' = -0{\cdot}0187$, if we make M = 800 and G = 11, as in section 30. These two horses, therefore, would not be able to draw a two-wheeled carriage over the point F of this excavation; whereas they could draw without much exertion, and with a velocity of more than 18 inches per second, a four-wheeled carriage over the same point. On the other hand, they would be obliged to employ nearly as great an exertion for the hind-wheels; but this double exertion will be less fatiguing than the single exertion in the case of two wheels provided they do not stick fast, as the calculation supposes.

III. *Single Elevations.*

Section 38.

Fig. 9. The case is the same when the obstacles which occur are single elevations, such as ridges, stones, broken pavement, and bridges, &c. Let G be an obstacle of this kind, the height of which is FR = b; let the semidiameter of the wheel

wheel be OG = a, ſo that cos. GOR = $\frac{a-b}{a}$. Let this angle GOR be for the fore-wheels = ρ, for the hind-wheels = σ, and for the two-wheeled carriages = τ. The increaſe of reſiſtance ariſing from this obſtacle in the caſe of the fore-wheels will be = $(\frac{1}{2}P + p)$ cos. α tang. ρ; in that of the hind-wheels = $(\frac{1}{2}P + p')$ cos. α tang. τ; and of the two-wheeled carriages $(P + \pi)$ cos. α tang. μ. But of the firſt two, as one only acts at a time, the whole reſiſtance on each kind of way where ſuch obſtacles occur will be much eaſier overcome by the four-wheeled than by the two-wheeled carriages.

Fifth Division.

General Conſiderations and Reſults.

Section 39.

I have already ſhown, in regard to all the three claſſes of roads in general, the conditions under which the one kind of carriage is to be preferred to the other. But as the multitude of elements which occur in all theſe formulæ render a general view of them difficult, it may not be ſuperfluous to collect here a few of the principal reſults as deduced from a cloſer compariſon of the general conditions.

Section 40.

On roads of the firſt claſs, when the axles and wheels are in the common ratio, the difference between R and R′ can never be very conſiderable. But as the wheels of the two-wheeled carriages are generally made as high or higher than the hind-wheels of the four-wheeled carriages, we ſhall always have R ⋗ R′ as long as P, ε and α are not very great. But if the road be exceedingly ſteep, and the load very high and heavy, we ſhall have R ⋖ R′; conſequently the four-wheeled carriages will be preferable.

Section 41.

In the commencement of this eſſay, ſection 2. among roads of this claſs, I included thoſe with ſolid broad ruts, to which every thing obſerved, in general, in regard to ſolid and ſmooth roads is applicable. But if the ſolid ruts are narrow and deep, a friction is produced on the ſides of the fellies which increaſes the reſiſtance; but I cannot determine accurately this increaſe, as we are unacquainted with the laws according to which this friction acts: all that we know of it, and it is ſufficient for our purpoſe, is, that the increaſe of reſiſtance thence ariſing is for four-wheeled carriages nearly double that for two-wheeled carriages;

carriages; and consequently on such roads the former deserve the preference, and the more so the narrower and deeper the ruts.

Section 42.

When the dimensions of the wheels and axles are in the common ratio, the difference on roads of the second class between R and R′ will be considerably greater than for the carriages examined section 40, and to the prejudice of the four-wheeled carriages; and the more rugged the road the steeper it must be, and the higher and heavier must be the load to make $R \prec R'$. On the whole, two-wheeled carriages on roads of the second class are always preferable in regard to resistance.

Section 43.

But on roads of the third class, the advantage inclines strongly to the side of the four-wheeled carriages; and it is decidedly so when the surface of the road consists of soft sand, moist tender earth, tough dirt, &c. so that the hind-wheels run in the ruts formed by the fore-wheels. For here we have unconditionally $R \prec R'$. But even in the case of dry soft sand or earth, or fluid dirt, where the ruts made by the fore-wheels immediately close up again, we shall have also $R \prec R'$ when the sum of the semidiameter of the fore- and hind-wheels is not much smaller than the diameter of the wheels of the two-wheeled carriages without regard to P, α and ε. In the last place, if the road be steep and the load heavy and voluminous, the two-wheeled carriages, to the prejudice of the necessary strength, must have very large wheels to make $R \prec R'$. On the whole, therefore, on such roads four-wheeled carriages are better.

Section 44.

On the roads with sinuosities of section 34 we have $R \prec R'$ when the angle $\delta = 0$, or vanishes; that is, when the distance between the excavations is greater than that between the fore and hind-wheels, or when they are placed so near each other that the hind-wheel sinks while the fore one ascends, as seen, figure 7, at F″ and F. In both cases, particularly the last, four-wheeled carriages are to be preferred to two-wheeled, not only because $R \prec R'$, but because the moving power remains greater in the former case than in the latter, where the continued alteration in the direction of the pole, and the vibrating of the centre of gravity which thence arises, tend greatly to fatigue the cattle.

Section

Section 45.

In the caſe alſo of ſingle excavations and elevations, ſuch as thoſe conſidered ſection 35 and ſection 38, we ſhall have, as already mentioned, $R < R'$ when ſuch occur on any road whatever. When theſe obſtacles are numerous, but not ſo near each other that the fore- and hind-wheels both experience a reſiſtance at the ſame time, four-wheeled carriages are for the moſt part to be preferred to two-wheeled, without taking into conſideration the nature of the road in other reſpects.

Sixth Division.

More accurate Determination of the Reſiſtance in regard to the Direction of the Pole or Shafts.

Section 46.

In the preceding reſearches it has been ſuppoſed that the direction of the pole of the carriage is parallel to that of the road. In general, however, it deviates more or leſs from this direction according as the breaſt leather or the collar of the team horſe is higher or lower than the axles of the wheels. This deviation depends alſo, beſides the length of the pole, on the kind of harneſs, on the height of the cattle and the method of yoking them, and on the ſize of the wheels; and when this is taken into conſideration the reſiſtance R and R′ will certainly be ſomewhat different from that found in the preceding diviſions. But though the difference is very ſmall, to render the examination of this queſtion as complete as the nature of the ſubject will admit, I ſhall take into conſideration in this diviſion the direction of the pole, and again determine the values of R and R′ for each of the ſuppoſed three claſſes of roads.

I. *Roads of the firſt Claſs.*

Section 47.

Let the pole OI, fig. 10. make with the direction of the road AB or OM an angle MOI = K, the moving power OI $= V = M\left(1 - \frac{g}{G}\right)^2$ is in this caſe not entirely employed, but only the part OM = V cos. $\varkappa$; while the other part, ON = V, ſin. $\varkappa$, leſſens the preſſure on the fore axle, which is only $\frac{1}{2}$ P cos. α, — V, ſin. $\varkappa$. Therefore the reſiſtance from friction on the axle $= \frac{1}{2} m \lambda$ P cos. α, $- m \lambda$ V, ſin. $\varkappa$; and the whole reſiſtance acting in the direction OP againſt the power OM = V cos. $\varkappa$ is,

$$\left\{\begin{array}{l} \frac{1}{2}(m+n)\,\lambda\,\mathrm{P}\cos.\alpha + (\mathrm{P}+p+p')\sin.\alpha \\ - m\lambda\,\mathrm{V}\sin.\varkappa = \mathrm{V}\cos.\varkappa \end{array}\right\}$$

If

If we therefore put for this clafs of roads $V = M\left(1 - \frac{g}{G}\right)^2 = R$, the required reſiſtance for four-wheeled carriages will be,

$$R = \frac{\frac{1}{2}(m+n)\,\lambda\,P\cos.\,\alpha + (P+p-p')\,\text{ſin.}\,\alpha}{\cos.\,\varkappa + m\,\lambda\,\text{ſin.}\,\varkappa}$$

If we make for two-wheeled carriages the angle MOI $= \varkappa'$ and $V = M\left(1 - \frac{g'}{G}\right)^2 = R'$, we ſhall find in the ſame manner,

$$R' = \frac{\mu\,\lambda\,P\cos.\,\alpha + (P + \varepsilon P + \pi)\,\text{ſin.}\,\alpha}{\cos.\,\varkappa' + \mu\,\lambda\,\text{ſin.}\,\varkappa'}$$

Where it is however to be remarked, that though $\varepsilon = \frac{OH}{OI}$ we have here OH = OS tang. $(\alpha + \varkappa')$. If $\varkappa = 0$, and $\varkappa' = 0$, then will $R = R$ (ſection 9), and $R' = R'$ (ſection 12).

EXAMPLE.

Section 48.

Let every thing be as in the example ſection 18, and, beſides, let IW = 42 inches. For R let OI = 10 feet, and for R' let OI = 12 feet, ſo that $\varkappa = 13^\circ\,30'$ and $\varkappa' = 7^\circ\,11'$; conſequently OH = 2 tang. $13^\circ\,11' = 0{\cdot}46848$, and $\varepsilon = 0{\cdot}03904$. Hence we ſhall have R = 199·557 and R' = 189·943. In ſection 18 we had R — R' = 9·510, and here R — R' = 9·614. Therefore the difference is nearly equal.

II. *Roads of the ſecond Clafs.*

Section 49.

On roads of this kind in the fore-wheels of four-wheeled carriages the momentum of the part K of the moving power, which is employed in order to raiſe it above the obſtacle G, is K.GU — OR.GR; that is, K.GO cos. $(\varphi - \varkappa)$ — $(\frac{1}{2}P + p)$ cos. $\angle$.GO ſin. φ. Hence the power K acting in the direction OH = $(\frac{1}{2}P + p)$ cos. α ſin. φ, ſec. $(\varphi - \varkappa)$; conſequently that in the direction OP = OH cos. α = $(\frac{1}{2}P + p)$ cos. α, cos. $\varkappa$, ſin. φ, ſec. $(\varphi - \varkappa)$. The ſum of all the powers acting in the direction of OP therefore is,

$$\left\{\begin{array}{l}(m+n)\,\lambda\,P\cos.\,\alpha + (P + p + p')\,\text{ſin.}\,\alpha \\ m\,\lambda\,V\,\text{ſin.}\,\varkappa + (\frac{1}{2}P + p)\cos.\,\alpha,\ \cos.\,\varkappa,\ \text{ſin.}\,\varphi \\ \text{ſec.}\,(\varphi - \varkappa) + (\frac{1}{2}P + p')\cos.\,\alpha\ \text{tang.}\,\psi\end{array}\right\} = \cos.\,\varkappa$$

Hence we obtain $V = M\left(1 - \frac{g}{G}\right)^2$; or,

$$R = \left\{R + \frac{(\frac{1}{2}P + p)\cos.\,\alpha\cos.\,\varkappa\,\text{ſin.}\,\varphi,\,\text{ſec.}\,(\varphi - \varkappa)}{\cos.\,\varkappa + m\,\lambda\,\text{ſin.}\,\varkappa} + \frac{(\frac{1}{2}P + p')\cos.\,\alpha\,\text{tang.}\,\psi}{\cos.\,\varkappa + m\,\lambda\,\text{ſin.}\,\varkappa}\right\}$$

And in the same manner we find for two-wheeled carriages,

$$R' = R + \frac{(P + \pi) \cos.\alpha \cos.\varkappa' \text{ sin. } \omega, \text{ sec. } (\omega - \varkappa')}{\cos.\varkappa' + \mu\lambda \text{ sin. } \varkappa}$$

If therefore $\varkappa = 0$ and $\varkappa' = 0$, we obtain for R and R′ the values found in the second division, section 19 and section 20.

Example.

Section 50.

Let every thing be as in the case calculated section 23; also let IW = 42 inches, for R let OI = 9 feet, and for R′ let OI = 12 feet: hence $\varkappa = 14^\circ\ 29'$, and $\varkappa' = 7^\circ\ 47'$. Now as OH = 2 tang. $21^\circ\ 47' = 0{\cdot}799268$ feet, therefore $\varepsilon = 0{\cdot}06660$. Hence we obtain,

$$R = \frac{(^1m + n)\,\lambda P \cos.\alpha + (P + p + p')\text{ sin. }\alpha}{\cos.\varkappa + m\lambda \text{ sin. } \varkappa} = 529{\cdot}268$$

$$\frac{(\frac{1}{2}P + p)\cos.\alpha \cos.\varkappa \text{ sin. } \phi, \text{ sec. } (\phi - \varkappa)}{\cos.\varkappa + m\lambda \text{ sin. } \varkappa} = 95{\cdot}836$$

$$\frac{(\frac{1}{2}P + p')\cos.\alpha \text{ tang. } \psi}{\cos.\varkappa + m\lambda \text{ sin. } \varkappa} = 72{\cdot}139$$

$$R = 697{\cdot}243$$

$$R' = \frac{\mu\lambda P \cos.\alpha + (P + \varepsilon P + \pi)\text{ sin. }\alpha}{\cos.\varkappa' + \mu\lambda \text{ sin. } \varkappa'} = 526{\cdot}260$$

$$\frac{(P + \pi)\cos.\alpha \cos.\varkappa' \text{ sin. } \omega, \text{ sec. } (\omega - \varkappa)}{\cos.\varkappa' + \mu\lambda \text{ sin. } \varkappa'} = 124{\cdot}021$$

$$R' = 650{\cdot}281$$

In the example section 23 we had $R - R' = 45{\cdot}357$, but here $R - R' = 46{\cdot}962$; consequently in this case the differences are nearly equal.

III. *Roads of the third Class.*

After what has been said, section 49, it is needless to repeat step by step the process for roads of this class. It may be easily seen that here,

$$R = \left\{ R + \frac{(\frac{1}{2}P + p)\cos.\alpha \text{ sin. } \beta \cos.\varkappa \text{ sin. } \xi}{\cos.\varkappa + m\lambda \text{ sin. } \varkappa} \right.$$
$$\left. \frac{\text{sec. } (\xi - \varkappa') + (\frac{1}{2}P + p')\cos.\alpha \text{ sin. } \beta \text{ tang. } \gamma}{\cos.\varkappa + m\lambda \text{ sin. } \varkappa} \right\}$$

$$R' = R' + \frac{(P + \pi)\cos.\alpha \text{ sin. } \beta \cos.\varkappa' \text{ sin. } \vartheta, \text{ sec. } (\vartheta - \varkappa')}{\cos.\varkappa' + \mu\lambda \text{ sin. } \varkappa'}$$

So that when $\varkappa = 0$, and $\varkappa' = 0$, we obtain for R and R′ the same values as those found section 26 and section 27.

Example.

EXAMPLE.

Section 52.

Let every thing be as before section 30; also IW = 48 inches, for R let OI = 9 feet, and for R′ let OI = 12 feet; therefore $\varkappa = 17^\circ\ 22'$, and $\varkappa' = 9^\circ\ 24'$. Now as OH = $2\frac{6}{7}$ tang. $13^\circ\ 24' = 0{\cdot}68067$, then is $\varepsilon = 0{\cdot}05672$. From these and the preceding data we obtain,

$$R = \frac{\frac{1}{2}(m+n)\,\lambda\,P\cos.\,\alpha + (P+p+p')\,\text{fin.}\,\alpha}{\cos.\,\varkappa + m\lambda\,\text{fin.}\,\varkappa} = 125{\cdot}403$$

$$\frac{(\frac{1}{2}P+p)\cos.\,\alpha\,\text{fin.}\,\beta\cos.\,\varkappa\,\text{fin.}\,\xi,\ \text{fec.}\,(\xi-\varkappa)}{\cos.\,\varkappa + m\lambda\,\text{fin.}\,\varkappa} = 117{\cdot}198$$

$$\frac{(\frac{1}{2}P+p')\cos.\,\alpha\,\text{fin.}\,\beta\,\text{tang.}\,\eta}{\cos.\,\varkappa + m\lambda\,\text{fin.}\,\varkappa} = 111{\cdot}453$$

$$R = 354{\cdot}054$$

$$R' = \frac{\mu\lambda\,P\cos.\,\alpha + (P+\varepsilon P+\pi)\,\text{fin.}\,\alpha}{\cos.\,\varkappa' + \mu\lambda\,\text{fin.}\,\varkappa} = 116{\cdot}055$$

$$\frac{(P+\pi)\cos.\,\alpha\,\text{fin.}\,\beta\cos.\,\varkappa'\,\text{fin.}\,\vartheta,\ \text{fec.}\,(\vartheta-\varkappa)}{\cos.\,\varkappa' + \mu\lambda\,\text{fin.}\,\varkappa'} = 216{\cdot}092$$

$$R' = 332{\cdot}147$$

In the example section 30, we had $R - R' = 16{\cdot}071$, but here $R - R' = 21{\cdot}907$.

LXII. *Reflections on the Zodiacs found by the French in Upper Egypt. By Mr.* DELUC *.

THE principal arguments opposed to the authenticity of what Moses relates in regard to the history of the deluge, and the period when it took place, are drawn from the supposed antiquity of our continents, which is carried back, without bounds, beyond that epoch. This opinion has its source in idea rather than in observation; for facts which have been carefully observed show, on the contrary, that the continents we inhabit have no older date than that fixed by the chronology of Moses since the flood. For the proofs of this truth I refer to *Lettres Physiques et Morales sur l'Histoire de la Terre et de l'Homme*, and to those *sur l'Histoire Physique de la Terre*, or *Lettres Geologiques*, where are collected a great number of facts the evidence of which cannot be contested.

But the project, long ago formed, of destroying the credit due to the revelation announced by the sacred historian, pre-

* From the *Bibliothèque Britannique*, No. 154.

vails, with fome, over evidence. No attention is paid by infidels to the proofs which confirm it; and, without having been able to deſtroy them, and even without having tried it, they return to the charge as ſoon as an opportunity offers.

The *Moniteur* or French *Gazette Nationale* of the 25th of Pluvioſe laſt (February 14, 1802,) contains a long article, in which are announced diſcoveries made in Upper Egypt, and among theſe is that of two zodiacs; from which it is "certain," ſays the writer, "that the preſent diviſion of the zodiac ſuch as we are acquainted with was eſtabliſhed among the Egyptians fifteen thouſand years before the Chriſtian æra, and that it has been preſerved without alteration and tranſmitted to all other nations."

This concluſion, given with a tone of aſſurance, may eaſily impoſe, and make it be believed that it is well founded, though it can reſt only on conjectures or miſtakes in the application of aſtronomical calculations: but in ſuch ſpeculations, as they are retained by no religious perſuaſions, they follow their own ideas, without ever inquiring whether they can be reconciled with what is pointed out to us by nature.

The Memoirs of the Academy of Sciences for 1708 contain an engraving of a large fragment of an Egyptian planiſphere or zodiac which was ſent from Rome to the academy. This zodiac, engraven on antique marble, was preſerved in the Vatican. It repreſents concentric bands or circles divided into twelve equal portions by lines drawn from the circumference to the centre. The circle in the centre, which is not divided, contains three conſtellations, the Dragon and two Bears. The next circle, which is divided, contains the figures of animals, reptiles, and others. The two following circles contain each in the ſame order the twelve ſigns of the zodiac, ſome of which are in good preſervation. The fifth circle, ſeparated by a band on which are traced out letters or characters, contains in each diviſion, correſponding to a ſign, three human figures, ſome of which have the head of an animal. And the laſt circle, which incloſes the whole, repreſents the planets repeated under the figure of human heads correſponding to certain diviſions of the ſigns, according as the imagination, inclined to the chimeras of aſtrology, ſuggeſted.

The learned in 1708 were far from aſſigning to this zodiac a high antiquity: it was even conſidered, and with juſtice, as being rather aſtrological than aſtronomical; and therefore it was left in the hiſtorical part of that year as a mere object of curioſity, not worthy of engaging the time of the academy.

But Voltaire and his ſchool had not yet appeared *ſeated in*

the

the ſcorner's chair, thowing out their ſophiſms and their ſarcaſms againſt the account given by Moſes. Theſe arms made their uſual impreſſion on inattentive men. They reject as fabulous the chronology of the ſacred hiſtorian; and, by a very remarkable but not novel inconſiſtency, they give more faith to the uncertain interpretations of theſe combined arrangements of the Egyptian ſigns and hieroglyphics, the date of which as well as the meaning is unknown, than to a chronology eſtabliſhed on an uninterrupted ſeries of generations.

Fortunately, without going far from the place where theſe zodiacs were found, a very remarkable fact of the philoſophy of the earth bears teſtimony againſt the antiquity aſcribed to them.

We know, from the accounts of enlightened travellers, that the coaſt of Arabia on the Red Sea is incumbered with banks or reefs of coral, which render acceſs to them difficult and dangerous.

Theſe reefs are the work and habitation of polypes, which in proportion as they labour abandon their firſt habitations, on which they continue to build. This ſucceſſion of labour is ſeen very diſtinctly in thoſe marine productions which ſerve to ornament our cabinets of natural hiſtory under the names of coral, madrepores, millepores, ſea organs, &c.

In warm climates theſe polypes are always in activity; they never ceaſe to multiply and to labour; the reſult of which is, that in a ſhort time they augment in a ſenſible manner the maſs of their habitations, which are not deſtroyed by age, as they are of the ſame ſubſtance as ſhells, and have the ſame hardneſs.

Niebuhr, in his Deſcription of Arabia, p. 199, mentions a ſtriking inſtance of the rapid increaſe of theſe coral banks obſerved at the diſtance of ſome leagues to the north of Mokha. "Ghaleſka, a town formerly celebrated," ſays he, "is at preſent a wretched village, the inhabitants of which, few in number, live on their dates and by fiſhing. The coaſt is at preſent ſo filled with coral banks, that the port is impracticable even to ſmall veſſels."

If only a few centuries then were required to render a port and the neighbouring coaſts impracticable, this rigorous conſequence reſults, that all theſe ſhores muſt many ages ago have been inacceſſible to ſhips, had the Red Sea, and the coaſts by which it is bordered, exiſted fifteen thouſand years before the Chriſtian æra, as is ſaid of the zodiacs of Upper Egypt, which would ſtill ſuppoſe many thouſands of years anterior to that period.

And when we reflect that, as we are no longer ſtopped in regard to the antiquity of our continents by any known chronology, the reſult is, that they may have exiſted millions as well as thouſands of years: there are no more bounds, then, aſſignable to their antiquity, and conſequently to the progreſs of the labour of theſe inſects; and the Red Sea, narrow and deep, ought to have been totally choked up by it.

But the Red Sea is not the only one which exhibits theſe coral reefs, and their continual increaſe: a great number of iſles ſituated between the tropics are ſurrounded by them in ſuch a manner as renders acceſs to them as difficult as on the coaſts of Arabia.

Mr. Labillardiere, the author of *Voyage à la Recherche de la Perouſe*, makes on this ſubject the following reflection, in conſequence of the veſſels having been expoſed to great danger among ſuch reefs, which extend around New Caledonia:—"Theſe polypiers," ſays he, "the continual increaſe of which blocks up more and more the baſon of the ſeas, are very capable of frightening navigators; and many ſhoals which ſtill afford a paſſage will ſoon form reefs exceedingly dangerous."

If the preſent ſtate of the ſeas and continents had exiſted for thouſands of ages, as pretended by thoſe geologues who reject the chronology of Moſes, is it not evident that theſe reefs, which continually increaſe, would have long ago ſurrounded theſe iſlands with ſo great a number of theſe walls of coral, that it would have been impoſſible for the firſt navigators to approach even within a conſiderable diſtance of them? Nature, then, agrees here with the chronology of the ſacred ſcriptures. The labour of theſe little animals riſes up from the bottom of the ſea, in teſtimony of the truth of its relation.

Theſe coral rocks appear to be a production peculiar to the preſent ſea; for we find nothing ſimilar in calcareous mountains, nor in hills conſiſting of ſhells. Coral and madrepores are, no doubt, found in them; but they are inſulated in the ſtrata like all other marine bodies. This example ſhows how deceitful the calculations of geometry may be, when applied to facts in the philoſophy of the earth without conſulting nature.

The celebrated geometrician Delaplace, calculating the depth of the ſea from the Newtonian theory of the tides, has determined that this depth cannot be leſs than four leagues*.

The attentive obſerver of nature has means more certain

* *Renouvellement périodique des Continens terreſtres*, p. 288.

for

for founding this depth than the result of such calculations. These are, the numerous volcanic isles scattered in all latitudes throughout the bosom of the most extensive seas. These islands attest, that the basis on which the subterranean fires have elevated them cannot be at the depth of even a thousand toises; and if we add to these volcanic isles all the natural isles which are at a great distance from continents, what will become of the depth of *four leagues*, assigned to the sea from these calculations?

Another fact, which opposes this hypothesis, results from currents. If the flux and reflux depended on the depth of the sea, it ought to experience the same libration throughout its whole mass; which is not the case. The currents are not sensible but at a small distance from the surface of the water.

This fact, which is well known to navigators, supplies them with the means of determining whether their vessel be in a current. They hoist out a boat, which proceeds to some distance from the vessel, and then let down a weight attached to a rope to the depth of 200 fathoms. This weight being thus at a great depth in calm water, observation and experience having shown that currents are not sensible beyond the depth of ten fathoms, it produces the effect of an anchor which retains the boat: they then throw into the water a very thin board, that the wind may have no hold of it, and according to the motion of this board, if it has any, they discover whether there be a current, and determine its direction and velocity. It results then from these facts, that the libration of the sea, occasioned by the moon, which produces the tides, is owing to its extent, and in no manner to its depth.

What then ought we to conclude from all these facts? That in regard to the philosophy of the earth we ought to consult them, and direct our observations in particular by the first of all motives, that of attaining, as far as possible, to the knowledge of truth.

I shall take this opportunity of making a remark connected with some observations contained in my letter of the 10th of November last. Since the currents of the sea are experienced only at a small depth, and as the sea beneath them is calm, the geological systems founded on the formation of new continents by currents at the bottom of the sea have not this supposed fact in their favour, since it is proved that they do not exist.

Geneva,
May 10, 1802.

LXIII. *Obſervations reſpecting the Aya-Pana. Read in the Claſs of the Phyſical Sciences of the French National Inſtitute on the 14th of Fructidor, Year 10.* By C. VENTENAT.

SEVERAL of the journals have lately made mention of the *aya-pana*. They have ſaid that this plant was originally a native of Brazil; that it is cultivated with ſucceſs in the Iſle de France; that it poſſeſſes great virtues, and may be conſidered as an univerſal panacea. I hope, therefore, that the claſs, and particularly phyſicians, will be gratified with a more complete account of this vegetable, the diſcovery of which is a valuable acquiſition to natural hiſtory, if the virtues aſcribed to it are not exaggerated.

About eight months ago one of my nephews, being about to leave the Iſle of France, begged citizen Michaud to point out to him ſuch plants cultivated in the garden of the ſtate as he thought likely to be an acceptable preſent to me. Our friend mentioned to him the rareſt articles: he even was ſo kind as to procure them, and did not forget the famous plant of Brazil. The information which my nephew obtained reſpecting this plant, being perfectly agreeable to that which has been ſince tranſmitted to madame Bonaparte as well as to C. Juſſieu, I flatter myſelf that I am able to give the claſs an accurate account in regard to every thing that concerns the native country of the *aya-pana*; the properties aſcribed to it; and, in particular, its botanical characters.

The *aya-pana* grows in South America on the right bank of the river of the Amazons. The inhabitants of that country have long conſidered it as an excellent ſudorific, and a powerful alexipharmic or antidote againſt the bite of ſerpents and the wounds made by poiſoned arrows. Its virtues are equally extolled throughout all Brazil, where it is carefully cultivated, and where it is diſtinguiſhed by the name of the *miraculous plant*.

In the 7th year of the French republic captain Auguſtine Baudin, brother of captain Baudin ſo well known to naturaliſts who is now on a voyage to the South Seas, being at Brazil, and having heard of the *aya-pana*, conſidered at firſt as fabulous, or at leaſt exaggerated, every thing told him reſpecting the virtues of this plant. But the relation of ſeveral cures performed by it during his ſtay in that country, confirmed by the teſtimony of perſons worthy of credit, and particularly by that of Dr. Camara, a celebrated botaniſt and able phyſician, who was formerly a pupil of Juſſieu, entirely removed his doubts.

Convinced that he ſhould render an important ſervice to the French colonies by introducing the *aya-pana*, captain Baudin made every effort to obtain it. With great difficulty he procured ſome roots, which he cauſed to be conveyed on board his veſſel, giving orders that the greateſt care ſhould be taken of them. When about to leave Brazil, being deſirous to ſee in what ſtate his ſlips of the *ay -pana* were, he found that, unfortunately, they no longer exiſted: they had been entirely deſtroyed by ſome fowls which had eſcaped from the hen-coop.

Captain Baudin was much afflicted at this loſs; and though his departure had been fixed for the next day, he reſolved to procure the *aya-pana* again, whatever it might coſt: but his demands were not complied with, and his offers were even rejected. A love of ſcience, and the deſire of being uſeful to his country, induced him then to paſs over certain conſiderations which, under other circumſtances, might have checked him. He remembered that there was a root of *aya-pana* in the window of an individual, which had been conſtantly refuſed to him: he formed the project of carrying it off in the night-time. Accompanied therefore by ſome ſailors he repaired to the place, and by means of long poles they threw down the pot which contained the plant. Captain Baudin immediately ſeized it, returned ſpeedily on board, and at day-break proceeded on his voyage to the Iſle of France.

Scarcely had captain Baudin landed in that French colony when he informed the director of the garden of the ſtate, that he had procured this valuable plant, with which he propoſed to enrich the colony. As the *aya-pana* is eaſily propagated by ſlips, the plant was ſoon multiplied; and at preſent there is ſcarcely a plantation where it is not cultivated.

The properties of the *aya-pana*, if the information communicated to me, and that ſince tranſmitted to madame Bonaparte and C. Juſſieu by captain Auguſtine Baudin himſelf, can be credited, are not belied at the Iſle of France, where this plant enjoys as great celebrity as in its native country. The garden of government is continually beſet by diſeaſed perſons, who come to ſolicit a few leaves of the *y -pana* to cure their maladies. The colonial gazette daily contains ſome new proofs of its virtues; and it is employed with ſucceſs not only againſt the bite of ſerpents, but alſo for curing the dropſy, ſyphilis in its moſt inveterate ſtages, and all ſorts of wounds.

Among the great number of cures effected at the Iſle of France by means of the *aya-pana*, and announced in the gazette already mentioned, I ſhall ſelect three or four, which will

will ſhow the manner of adminiſtering this plant, and the different doſes employed, according to the purpoſes for which it is applied.

A planter of the Iſle of France, C. Cotte, was ſtung in the right hand by a ſcorpion: a violent inflammation, accompanied with acute pain, immediately took place. Captain Baudin adviſed him to make uſe of the *aya-pana*. Several leaves were pounded, and applied to the wound; the pain immediately ceaſed: at the end of two hours there was no more inflammation, and the hand ſoon returned to its natural ſtate.

C. Ponſet, an officer of artillery, brought to captain Baudin a negro, who while fiſhing had been pricked by a fiſh known under the name of the *laſt*. The prick of this fiſh is ſo venomous that, before the *aya-pana* was known, amputation of the wounded limb was the only remedy. The hand of the negro was very much ſwelled. Captain Baudin recommended the application of the *aya-pana* pounded; and as he ſuppoſed that a great deal would be required to effect a cure, he induced C. Poncet to ſend ſome perſon to the garden of the ſtate to procure a conſiderable quantity of the leaves, in order that the hand of the patient might be wrapped up in them. But as the garden was at the diſtance of three leagues, and as the patient ſuffered a great deal from the pain of the wound, captain Baudin reſolved to take ſeven or eight leaves from a young ſhoot which he had at his houſe. Theſe he cauſed to be pounded, and then applied to the part affected. Next day the hand of the black was completely cured.

A black whoſe belly was much ſwelled, and exhibited ſymptoms of a dropſy, having applied to a ſurgeon, the latter reſolved to tap him: he, however, deferred the operation becauſe he had other patients to viſit. Being urged by the maſter of the black to preſcribe for him, he ſaid, by way of deriſion, "Give him an infuſion of *aya-pana* till I return." The ſurgeon's orders, happily for the patient, were literally complied with. The dropſy made no further progreſs; the ſymptoms gradually diſappeared; and at the end of a few days the black was in a condition to reſume his labours.

Captain Baudin, in going on board his veſſel, happened to fall and hurt his left leg very much. It was neceſſary, on his being carried home, to cut off his ſtocking in order that the wound might be dreſſed. Captain Baudin ordered ſome leaves of the *aya-pana* to be boiled; and when the decoction was tepid the wounds were waſhed with it, and the leaves uſed for making the decoction were applied to them. The leg was then wrapped up in ſeveral folds of a bandage dipped

in the ſame liquor, beſprinkling it anew every ten minutes. About two hours after the firſt dreſſing the inflammation had ſo much abated that the patient was able to walk with the help of a ſtick, and at the end of thirteen days he was perfectly cured.

I could mention a great many more cures effected by means of the famous plant of Brazil; but, as it is not prudent to certify any facts of which one has not been a witneſs, we ought, in my opinion, to wait till the virtues of the *aya-pana* have been confirmed by the continued obſervations of able phyſicians. The teſtimony, however, of captain Baudin, and that of ſeveral perſons lately arrived from the Iſle of France, are entitled to ſome confidence, and give us reaſon to hope that the *aya-pana* may increaſe the number of our vegetable productions employed for relieving or curing the evils incident to the human race.

It is to be preſumed that this plant will be ſoon multiplied in the gardens of the capital. C. Michaux, who has rendered ſo great ſervices to botany and agriculture, has ſent ſeeds of it to C. Cels, and madame Bonaparte has received ſome from the director of the garden of the ſtate: but, as the ſeeds do not always produce plants, it is to be wiſhed that ſome living ſhoots of it could be obtained: they might eaſily be multiplied from ſlips, and it might then be poſſible to form ſome deciſive opinion in regard to the virtues aſcribed to this plant.

Though we are allowed to doubt the virtues of the *aya-pana*, the botanical characters of this plant are ſo ſimple and eaſy to be known, that there cannot be the leaſt uncertainty in reſpect to the genus to which it ought to be referred. The examination I have made of ſeveral complete plants has proved to me that it belongs to the family of the *corymbiferæ*, and that it belongs to the genus *eupatorium* of Linnæus.

The ſtem of this plant, which I have called *eupatorium aya-pana*, is ſtraight, full of branches, of a dark brown colour, about three feet in height, and of the ſize of a gooſe-quill. Its leaves are alternate, almoſt ſeſſile, lance-formed, and very entire; the flowers are of a bright purple colour, and diſpoſed in corymbi at the ſummit of the ſtem and branches.

The *eupatorium aya-pana* may be diſtinguiſhed from other ſpecies of this genus by the following character: *Eupatorium foliis lanceolatis, integerrimis, inferioribus oppoſitis, ſuperioribus alternis; calicibus ſubſimplicibus, multifloris* *.

* A deſcription of a plant poſſeſſing ſimilar properties to the *aya-pana*, and agreeing with it in ſeveral of its characters, may be ſeen in our laſt volume, p. 36.—EDIT.

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A figure and a more extenſive deſcription of the botanical characters of the *aya-pana* will be found in the firſt number of the *Plantes du Jardin de la Malmaiſon*, which will appear in a few months.

P. S. I have received from madame Bonaparte a quantity of the dried leaves of the *aya-pana*, which I have delivered to citizen Alibert, phyſician to the hoſpital of St. Louis, profeſſor of the materia medica, to determine, by experiments, its medical properties.

LXIV. *General Conſiderations on Vegetable Extracts.* By C. PARMENTIER *.

MODERN chemiſts have denoted under the name of *extract*, or rather that of *extractive matter*, and placed among the number of the immediate materials of vegetables, a ſubſtance the diſtinguiſhing characters of which, when in its ſtate of purity, are: it is ſoluble in water; after a proper evaporation of the juices, or of the decoction which held it in ſolution, it becomes a ſolid tranſparent body, and, when the evaporation has been too rapid, an opake maſs, more or leſs inſoluble; in both caſes it is coloured, and has a ſavour always acid, and more or leſs bitter, acrid, or harſh.

They have found alſo in extractive matter the property of combining with alkalies; of ſtrongly attracting oxygen; of being precipitated by acids, alum, metallic ſolutions, and oxides; and of being able, with the help of mordants, to adhere to ſtuffs like the colouring part of vegetables.

The medicines known in pharmacy under the name of extracts do not exhibit this extractive matter pure and unmixed, as it ought to be in order to be chemically examined.

Extracts are productions obtained by the evaporation of juices or infuſions, or the decoctions of plants under different degrees of conſiſtence, from that of honey to the dry or pulverulent ſtate.

They are often very compound mixtures, which contain,

1ſt, All the immediate materials of vegetables which the water can carry with it, whether naturally ſoluble, or whether they acquired that property both by the help of caloric and the reciprocal action which they exerciſe on each other.

2d, All the combinations which theſe immediate materials can form with each other during the evaporation.

3d, All the ſoluble reſults of the decompoſitions they have experienced.

* From the *Annales de Chimie*, No. 127.

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We may give an idea of the variety of the ſubſtances which are, or may in general be contained in pharmaceutic extracts, by preſenting thoſe which have been found in the ſap, juices, infuſions, and decoctions of vegetables.

Before the intereſting analyſis of ſeveral kinds of ſap by Deyeux and Vauquelin, chemiſts were far from imagining that liquors ſo limpid, and in appearance ſo ſimple, were ſo much compounded as they really are.

The above celebrated chemiſts found in them the carbonic and acetous acid; acetites and carbonates of potaſh and lime; muriate, ſulphate, nitrate of potaſh, &c.

The ſap of the vine and horn-beam tree furniſhed a vegeto-animal matter.

That of the oak and beech-tree preſented gallic acid, tanning principle, and two ſorts of extracts.

That of the birch and maple gave a very abundant ſaccharine matter.

Of theſe different ſubſtances diſcovered in ſap, and of thoſe which exiſt in the expreſſed juices of freſh herbaceous plants, in thoſe of fruits, in the infuſions and decoctions of dried plants, and of all the ſolid parts of vegetables, we may, with ſufficient foundation, form the following liſt:

1ſt, Mucous matter or mucilage: it is obtained from ſeeds infuſed in water; there are ſome plants which contain it in great abundance, for example the mallows:

It oozes from the bark of ſeveral trees under the name of *gum*.

2d, The acid mucous matter: it exiſts in lemons, oranges, granadillos, &c.

3d, The acid and ſaccharine mucous matter: it is contained in apples, pears, grapes, &c.

4th, Sugar: it is found in ſeveral roots, in the ſap of certain trees; it iſſues under a fluid form from the bark of ſome of them, and becomes condenſed; it bears the name of *manna*: it exiſts in the gramineous ſtems, very little in the leaves, almoſt always in the ſtate of nectar, of honey, or mucoſo-ſaccharine matter. It abounds in fruits, and is not perceptible in the ſeeds until they have experienced germination, and particularly in berries. The ſugar-cane and maple give it pure and cryſtallized.

It is difficult to obtain it in the dry ſtate from other vegetables either, becauſe it is much more embarraſſed by the mucilage, acid, and extractive matter, &c. whether it exiſts in them under a different modification or in a ſtate of imperfection.

5th, Mucous matter combined with a reſin; it may be diſtinguiſhed

diſtinguiſhed in plants which, like the *tithymalli*, give milky juices: nature preſents us with ſuch a combination in reſinous gums, ſuch as gum ammonia, aſſa-fœtida, &c.

6th, Extractive matter: it is always united with other immediate materials of vegetables, and is found in greater quantity in plants which have come to maturity, in ligneous roots, wood, bark, and dried leaves, than in vegetables or thoſe parts of vegetables where mucous matter prevails.

7th, Colouring principle: there are two kinds of it.

1ſt, That which, combined with mucous or extractive matter, is ſoluble in water; it is ſeen in flowers under the ſkins of fruit, in Indian wood, the root of madder, &c.

2d, That which, when fixed on any reſinous ſubſtance united with extractive matter, is rather carried away than diſſolved by boiling water, and may form part of extracts. It exiſts in the root of the walnut-tree, in ſandal wood, in the bark of the alder-tree, in the huſk of walnuts, &c.

8th, The tanning principle. This ſubſtance has an aſtringent ſavour, which particularly diſtinguiſhes the oak, the gall nut, &c. The maceration of theſe ſubſtances has the property of precipitating and rendering inſoluble the animal gelatin, of hardening it in leather, which by theſe means can be preſerved for a long time without alteration.

The tanning principle is often accompanied with gallic acid, which may be diſtinguiſhed by the property it has of precipitating iron black, and which was thought to belong to that principle called aſtringent, and which bears the name of *tannin*.

9th, The aroma. This is the volatile and odorous principle, which, being differently modified in many plants, gives to each of them an odour by which it is characterized.

It reſides, in particular, in volatile oils. Perhaps it is nothing elſe than theſe oils themſelves, more or leſs combined with other vegetable principles, which facilitate its ſolution in water, and which, in ſeveral caſes, give it a certain fixity: but ſome chemiſts have entertained doubts reſpecting the exiſtence of aroma diſtinct from the other materials of vegetables.

Extract of opium, indeed, retains the virous odour of the poppy, notwithſtanding the continued heat which the juice of that plant experiences during its evaporation.

Extracts of rue, ſavine, and wormwood, retain the odour of theſe plants; and the ſugar, carried to a very high temperature in the preparation of roſe and orange flower tablets, ſtill exhales a very ſenſible odour of the flowers which have been employed.

And

And in dragees called *orangeat*, the bark of the orange-tree, baked in a great deal of water till it loſes its odour and taſte, reſumes enough of both to be agreeable when it is confectioned in ſugar.

10th, Amylaceous fecula. This is a white, dry, pulverulent ſubſtance, without ſavour and ſmell, inſoluble in cold but ſoluble in warm water, with which it aſſumes the gelatinous ſtate of glue.

It is extracted from gramineous ſeeds, tuberous roots, and ſeveral fruits.

11th, Gluten. This is a gray ſubſtance, of an inſipid taſte, with the odour of horn ſlightly heated, of a ſoft, gluey, tenacious and elaſtic conſiſtence, which is obtained in a ſtate of purity only from the farina of wheat.

It is dry and pulverulent in the farina; but during the operation it is ſaturated with the quantity of water neceſſary to aſſume the ſtate of ſoftneſs, elaſticity, and ductility, under which it appears.

It is this matter which in the fermentation of bread gives to the farina of wheat the moſt decided pre-eminence over that of all the other gramineous plants, which contain none of it, or which, like barley, rye, and oats, contain only the materials of it.

Some chemiſts have imagined that they could diſcover the exiſtence of it in ſeveral vegetables.

12th, Sulphur: a ſimple, yellow, dry, cryſtallizable, inflammable, and well known ſubſtance, which was thought to exiſt only in minerals, and which is found in ſeveral vegetables, thoſe plants called antiſcorbutic, the root of the patience, dock, &c. and even in animals.

13th, Vegetable acids. Theſe are very much multiplied, though they may be conſidered as modifications of one and the ſame acid.

Their diſtinguiſhing characters are: that they become decompoſed in the fire, emitting an empyreumatic odour, and leaving a carbonaceous reſiduum; that they even poſſeſs the property of being volatile, a property which may be employed with great advantage for obtaining them in a greater degree of purity.

Thoſe beſt known are:

1ſt, The gallic acid: it exiſts in the gall nut, the bark of the oak, &c.

2d, The benzoic acid: it is found in benjamin and other balms and reſins.

3d, The citric acid: it abounds in lemons, gooſeberries, &c.

4th,

4th, The malic acid: it is contained in apples, ſtrawberries, raſpberries, &c.

5th, The oxalic acid: it exudes from the hair of vetches.

6th, The acetous acid. According to ſome chemiſts, it is not always the product of the fermentation known under that name; it is obtained ſometimes by the action of the ſulphuric and muriatic acids on vegetable ſubſtances. C. Vauquelin found it in the ſap of trees.

7th, The oxalic acidulum. This is a non-ſaturated combination of the oxalic acid with potaſh: it is furniſhed by ſorrel.

8th, The tartarous acid. It is found cryſtallized in large quantity on the ſides of caſks in which wine has remained; but it exiſts alſo in tamarinds, the barberry buſh, &c.

Theſe acids are either inſulated in vegetables or combined with earths, either calcareous or aluminous, and alkalies.

To theſe ſaline combinations, which with the two acidula may be conſidered as the real eſſential ſalts of vegetables, we might add other ſalts which are often found in them: of this kind are the ſulphates of potaſh and ſoda, the muriates of potaſh and ſoda, the nitrate of potaſh.

Theſe laſt ſalts, according to the obſervations of chemiſts, are products in vegetables merely by the power which reſides in them, and which have the faculty of compoſing them perfect, of uniting and combining the principles which can conſtitute them, but in different proportions, ſince it may depend on a pre-exiſting ſaline atom.

Certain plants in which nitrate of potaſh is found are fonder of earth which contains it: pellitory, in particular, ſeems to chooſe, that it may grow there at its eaſe, the bottom of a wall well furniſhed with ſaltpetre.

When the ſea, impelled by an impetuous wind, enters through the mouth of a river at a time when it is leſs abundant in water; when it penetrates very far into the country through the ſmall canals by which it is watered, and drenches with brine the plants that uſually grow on their banks; theſe plants ceaſe to have a deſire for inhabiting them; they die; and their place is ſoon ſupplied by other vegetables to which this moiſture is ſuited, neceſſary, and indiſpenſable.

This is exactly what has taken place at the mouths of the Nile. One branch in particular of this river, that of Damietta, oppoſed for ſome time, by a peculiar circumſtance, leſs reſiſtance to the waters of the ſea: it received and ſtill receives them during that part of the year when it is loweſt; and ſince that period ſeveral of the plants which grew in the canals

canals in the neighbourhood of Damietta, and which could not bear to have their roots immerſed in earth moiſtened by water leſs freſh than before, have diſappeared; ſo that the papyrus, which was very abundant in that diſtrict, is now exceedingly rare. The papyrus has abandoned its native country.

Inſtead of this liſt, it would be more advantageous to be able to preſent an exact analyſis of each pharmaceutic extract in particular. This would be the means of enlightening the apothecary in regard to their preparation, and the phyſician in regard to their virtue; but the labours of modern chemiſts on this point are ſtill very deficient, and the antient pharmacopoliſts never thought of undertaking this object, which they would not have been able to accompliſh with the neceſſary chemical knowledge. For want of better materials, they collected very juſt obſervations; ſo that, guided by them, and authorized by the example of nature, which in reſinous gums, ſap, and reſins, preſented them with products very ſimilar to the different extracts, they arranged the latter into four claſſes:

1ſt, Gummy extracts. They reſemble glue and jelly, and are furniſhed by the ſeeds of the flag, mallows, &c.

2d, Gummy reſinous extracts. Theſe are thoſe which contain gum and reſin united together. They are obtained from jalap, aloes, &c.

3d, Saponaceous extracts. Theſe are thoſe in which the gummy and reſinous principles are ſo well combined that they do not ſeparate. Of this kind are extracts of the carduus benedictus, fumitory, &c.

4th, Reſinous extracts. Theſe are the reſins properly called, obtained either by means of alcohol, which gives them more or leſs pure, or by means of ether, which furniſhes them abſolutely freed from gummy principle.

The different extracts have received different names.

Robe, ſapa, defrutum, jelly, extract.

Robe is the juice of any fruit inſpiſſated to the conſiſtence of honey.

Sapa is the juice of grapes evaporated to the ſame degree.

Defrutum is the ſame juice deprived of two-thirds of its humidity, and which being left to ferment in this ſtate gives baked wine.

Jelly is the infuſion or decoction of the mucilaginous ſubſtances of vegetables, or the gelatinous parts of animals concentrated to the proper degree.

Extract is the product of the evaporation of vegetable juices, infuſions, or decoctions.

As the object which pharmacopolists proposed by preparing these different extracts was to concentrate and preserve in a small volume the virtues and properties of vegetables, it is necessary that we should give a view of the means they employed to accomplish this object, such as the extraction of the juices of green plants; maceration, infusion, or the decoction of dried plants; and evaporation.

[To be continued.]

LXV. *Biographical Memoirs of Dr.* Robison, *of Edinburgh.*

SOME time ago we gave a head of Dr. Robison, with a very brief account of his life collected from such imperfect materials as we could at that time obtain. As we have since learnt that this sketch was incorrect in several particulars, and as it always gives us pleasure to rectify any errors into which we may inadvertently fall, we are happy to have it in our power to lay before our readers a more correct life, written by a gentleman of distinguished literary abilities, and who, from his intimacy with the professor, must be perfectly acquainted with the subject. Dr. Gleig, the gentleman alluded to, in a letter to the editor of the Anti-jacobin Review, to whom this life was first communicated, expresses himself in the following candid manner:

In the tenth volume of the Philosophical Magazine are Memoirs of the Life of John Robison, LL.D. &c., Professor of Natural Philosophy in the University of Edinburgh; the author of which has, indeed, done justice to the professor's general character as a man of science and of virtue, whilst he has stated inaccurately almost every incident of his life. To point out the numerous mistakes into which he has fallen, and correct them in a table of *errata*, would serve no purpose, because to such tables attention is seldom paid; and being an absolute stranger to the conductor of that publication, I cannot request him to fill, with a second life of my friend, pages professedly devoted to the improvement of useful arts and physical science. Perhaps it may gratify curiosity to inform the public, that the engraved portrait of Dr. Robison, which accompanied the Memoirs in question, appears to me a strong, though perhaps not flattering, likeness.

I am, Sir, your most respectful humble servant,

Stirling, Dec. 24, 1801. George Gleig.

John

JOHN ROBISON, LL.D. is a younger ſon of the late John Robiſon, eſq. of Boghall, in the county of Stirling.

Mr. Robiſon, the father, engaged, at an early period of life, in commerce, and carried on, for many years, a lucrative trade as a merchant in Glaſgow; but before the birth of the ſubject of this memoir he had retired from buſineſs, and lived on his eſtate. He is remembered both in Glaſgow and in the country with much reſpect, as a man of great piety, honourable in his commercial dealings, kind to the poor, and a good landlord.

Dr. Robiſon was in 1739 born at Boghall, where he paſſed the early years of childhood; but there being no ſchool of any note in the pariſh of Baldernock, where Boghall is ſituated, he received the whole of his education in Glaſgow. His progreſs through ſchool muſt have been rapid; for before he was nineteen years of age he had completed the uſual courſe of ſtudy in the univerſity.

I have indeed often heard him regret that he was but a careleſs ſcholar: but his apprehenſion is ſo quick, and his memory ſo retentive, that he muſt have acquired a competent knowledge of the Greek and Latin languages with very little labour. His knowledge of theſe languages now is ſuch as few men poſſeſs whoſe lives have been devoted to the purſuits of ſcience; and this, in all probability, it would not have been; had not a ſolid foundation been laid at ſchool. Senſible, however, that by greater exertion he might have done more than he did, he regrets, at preſent, what moſt men, who were clever boys, have cauſe to regret, that, at ſchool, he contented himſelf with barely ſurpaſſing his duller claſsfellows.

In the univerſity he had the happineſs of ſtudying under the profeſſors Moore, Simſon, Smith, Dick, and Leechman, whoſe eminence as teachers of the Greek language, of mathematics, moral philoſophy, natural philoſophy and theology, will be long remembered in Glaſgow. To mathematics he had no particular predilection till he perceived the uſe of that ſcience when ſtudying natural philoſophy under Dr. Dick; and to algebra he has at no period of his life been partial. Dr. Simſon's lectures were not, indeed, calculated to make any of his pupils partial to that branch of ſcience; and I have heard Dr. Robiſon ſay, that he firſt attracted the regard of that admirer of antient geometry by owning his diſlike of algebra, and by returning a neat geometrical ſolution of a problem which had been given out to the claſs in an algebraic form. With this mode of ſolution the profeſſor was delighted, though the pupil candidly acknowledged that it had

been adopted only becauſe he could not ſolve the problem in the manner required of the claſs.

Of the knowledge which Dr. Robiſon now poſſeſſes of mathematical ſcience in all its branches I need ſay nothing, ſince I have been the inſtrument of communicating ſome valuable ſpecimens of it to the public; but I know that, even yet, he delights much more in geometry than in any of the modes of algebra, aſſigning, as the reaſon of his preference, that in the longeſt demonſtration the geometrician has always clear and adequate ideas, which the moſt expert algebraiſt can very ſeldom have.

Dr. Dick, who had been conjoined with his father in the profeſſorſhip of natural philoſophy, dying in the year 1757, Mr. Robiſon offered himſelf to the old gentleman as an interim aſſiſtant; and, though then not nineteen years of age, he had the honour to be recommended as fit for the office by Dr. Adam Smith, afterwards ſo well known by his celebrated work on the Wealth of Nations. Profeſſor Dick, however, thought him too young; but, acknowledging his merit, he joined with Dr. Simſon in recommending him to Dr. Blair, prebendary of Weſtminſter, whom they underſtood to be in queſt of a young man to go to ſea with Edward duke of York, and read mathematics with his royal highneſs and a young officer who was to attend him as a companion. Though this employment had been declined by another gentleman, Mr. Robiſon embraced with eagerneſs ſo favourable an opportunity of eſcaping from the clerical profeſſion, from which, though deſigned for it by his father, whom he revered, and could not diſobey, he had acquired an inſuperable averſion. That averſion aroſe not, however, from any determination formed by him to devote his life to the advancement of mathematical ſcience, and ſtill leſs from any diſlike which he had conceived to the ſtudy of theology; but from circumſtances which, though they did credit to his head and heart, were ſuch as would not intereſt the public. No man, I believe, has juſter notions of the importance of theological knowledge, or a more ſincere regard for the faithful miniſters of religion, than profeſſor Robiſon; and certainly no man has a more rooted abhorrence of hypocriſy in all its forms.

Without any very diſtinct notion how he was to be employed, or what were to be the emoluments of his office, Mr. Robiſon went to London in 1758. There he ſoon diſcovered that the hopes with which he had been flattered, of reading mathematics with the duke of York, were built upon no other foundation than ſome vague ſcheme of Dr. Blair's, in caſe his royal highneſs ſhould go to ſea the enſuing ſummer;

mer; and it is not to be doubted but that he felt the diſappointment. He acknowledges, indeed, that he felt it ſeverely; but, as he could not think of returning to Glaſgow, he embraced the opportunity of ſtill going to ſea as mathematical tutor to Mr. Knowles, eldeſt ſon of admiral Knowles, and the intended companion of the duke of York.

With that gentleman he went, in 1759, on board the Neptune, of 90 guns, bound to Quebec; and Mr. Knowles being on the voyage appointed lieutenant on board the Royal William, Mr. Robiſon accompanied him, and, at his own requeſt, was rated midſhipman. I have often heard him ſay that in the Royal William he ſpent the three happieſt years of his life. When he gave me the article Seamanſhip, which is publiſhed in the *Encyclopædia Britannica*, he ſaid it was the ſuperior ſeamanſhip of captain Hugh Pigot which ſo forcibly turned his attention to that noble art, and gave him ſuch a love for the profeſſion that it is ſtill a favourite ſubject of his thoughts. Indeed, I believe that, if he ever formed a determination to devote his life to the improvement of any art or ſcience, it was at this time to the improvement of the art of ſeamanſhip. When captain Pigot took the charge of the ſhip, which during very ſtormy weather he generally did, the addreſs with which he made her do whatever he pleaſed, after ſhe had baffled the efforts of the officers of the watch, filled the mind of Mr. Robiſon with delight and wonder. It excited in him an ambition to rival ſuch ſkill, whilſt he confeſſes that he deſpaired of ever ſurpaſſing it.

It was on board the Royal William, in the river St. Lawrence, that Mr. Robiſon firſt noticed a connection between the *aurora borealis* and the direction of the magnetic needle. Pointing out the circumſtance to the gentlemen on the quarter deck, he got the remark inſerted in the St. James's Evening Chronicle, and afterwards in the London Chronicle, with an invitation to navigators to pay attention to the ſubject, and communicate their obſervations to the Royal Society.

A reinforcement of men being wanted for the ſhips lying before Quebec, lieutenant Knowles and a hundred ſeamen, with petty officers, were received from the Royal William on board the Stirling Caſtle, where ſir Charles Saunders had his flag. There Mr. Robiſon ſaw much ſervice both on board and aſhore, and was ſometimes employed in taking ſurveys of different parts of the river. Returning to the Royal William when Quebec was taken, he ſpent the whole of next year and part of the following in the bay of Biſcay, and on the coaſts of Spain and Portugal.

Lieutenant Knowles being appointed to the command of

the Peregrine sloop of war, Mr. Robison accompanied him; but those friends soon after parted, never to meet more. In 1762 the subject of this memoir was sent, by the admiralty board, to Jamaica, to make trial of Harrison's time-keeper; and, on his return, he learned, with grief, that the Peregrine had foundered at sea, and that his beloved friend and pupil, with the whole crew, had perished.

His prospects were now not flattering. Admiral Knowles had retired to the country in deep affliction for his son; lord Anson, on whose promise of future preferment Mr. Robison had gone to Jamaica, was dead; in the friendship of Dr. Blair he had little confidence; peace seemed to be at no great distance; and his hopes of advancement in the navy were very small.

He determined therefore to return to college, being assured by admiral (then sir Charles) Knowles, that he would send his remaining son as soon as he should have passed through the forms of Eton school, to complete his education under his inspection. Next year Mr. Mac-Dowell jun. of Castle Semple (now of Garthland, and M. P.) was placed under his care; and soon afterwards he carried from London to Glasgow Mr. Knowles, now sir Charles Knowles, and a rear admiral.

It was when he returned to college from the navy, as I have heard Dr. Robison say, that he seriously began to study; but his helps were gone. Dr. Simson was dead, Dr. Smith soon left Glasgow to travel with the duke of Buccleugh, and Dr. Moore was greatly changed. He attended, however, the lectures of Mr. Miller, the late celebrated professor of civil law in the university of Glasgow, and those of the still more celebrated Dr. Black, on chemistry; and finding in Dr. Reid, who succeeded Dr. Smith, and in Dr. Alexander Wilson, professor of astronomy, minds congenial with his own, he soon formed with these two men a very close intimacy. He speaks likewise with great affection of Dr. Wight, professor of history, and of Dr. Stevenson, professor of medicine, and in terms of high respect, indeed, of all the members of that learned body. That the respect between them and him was mutual is apparent from many circumstances.

When Dr. Black was called, in 1767, to Edinburgh, the senate of the university of Glasgow, on his recommendation, appointed Mr. Robison to succeed him as lecturer on chemistry. He read lectures on that science for three years with great applause, and had among his pupils men who have since distinguished themselves among the most eminent chemists of the age.

In 1770 sir Charles Knowles, being invited to St. Petersburgh by the empress Catharine II. to assist her in reforming her

her marine, requeſted Mr. Robiſon to accompany him in the capacity of his official ſecretary, with a ſalary of 250l. a-year. Mr. Robiſon's attachment to the navy, and to his affectionate friend and patron, being as ſtrong as ever, and a lecturer not having the ſame rank in the univerſity of Glaſgow with a profeſſor, the requeſt was cheerfully complied with.

It would appear that his conduct at St. Peterſburgh, and the knowledge which he had occaſion to exhibit in the view of the admiralty college, had powerfully recommended him to that board; for in 1772 he was appointed inſpector-general of the corps of marine cadets,—an academy conſiſting of upwards of four hundred young gentlemen and ſcholars, under the tuition of about forty teachers. As the perſon who fills this office has the rank of lieutenant-colonel, it became neceſſary, by the cuſtoms of Ruſſia, that Mr. Robiſon ſhould prove himſelf a gentleman, or what is there called a *dvoranin*; and the proof required was entered on record.

As inſpector-general he had nothing to teach, nor did he ever teach mathematics in any ſchool during his reſidence in that vaſt empire. His duty was to viſit daily every claſs of the academy; to receive weekly reports from each maſter, ſtating the diligence and progreſs of every perſon in his claſs; and twice a-year to advance the young gentlemen into the higher claſſes, according to their reſpective merits. Of theſe he was conſtituted the ſole judge, and from his ſentence there lay no appeal.

In juſtice to a ſtranger and foreigner, it is proper to add, that, when ſpeaking of this part of his duty, Dr. Robiſon always mentions in terms of high reſpect the enlightened and honourable conduct of general Kutuzoff, who was military head of the academy, and held the third place in the admiralty college. He repreſents the behaviour of that general to himſelf as more like the behaviour of a parent than of a ſuperior; for he approved of all his deciſions, adopted all his meaſures, ſupported his authority againſt intrigue and oppoſition, and introduced him to the grand duke as an admirer of the Ruſſian language, of which his imperial highneſs was the declared patron. This was a very powerful recommendation; for, however abſurdly Paul ſeems to have conducted himſelf on the throne, he had taſte enough, when grand duke, to feel the beauties of that language, and to befriend foreigners, who, like the ſubject of this memoir, had ſtudied it with ſucceſs.

Dr. Robiſon had not the honour of being at all known to the empreſs; nor did I ever hear him ſpeak of being con-

cerned in any plan for supplying her palace with water; though I recollect a converſation between him and me, occaſioned by the deſcription of a ball-cock * in one of our newſpapers, which could not have failed to lead to the mention of ſuch a plan had he known any thing of it. I have, however, heard him ſay, that he preſented to the admiralty college a plan for rendering the magnificent docks at Cronſtadt of ſome uſe by means of a ſteam-engine; and that the plan was adopted, and executed with ſucceſs after he left Ruſſia.—*Tulit after honores.*

He quitted that empire not becauſe the emoluments of his appointments were comparatively ſmall, for they were much greater than thoſe of his appointment in Edinburgh, but becauſe, the academy being at Cronſtadt, a diſmal ſolitude, he found his ſituation extremely irkſome. Had it been at Saint Peterſburgh, the ſociety of Euler and Æpinus, to whom he was known, as well as of many Ruſſian gentlemen whom he ſpeaks of as poſſeſſing Britiſh hearts, might have reconciled him to that capital; but to get away from Cronſtadt he accepted with pleaſure the invitation of the magiſtrates and town council of Edinburgh to be profeſſor of natural philoſophy in their univerſity. The grand duke parted with him reluctantly, and requeſting him, when he left the academy, to take with him ſome young men of talents from the corps of cadets: he promiſed him a penſion of 400 rubles (80 l.) a-year. That penſion was regularly paid only during the three years that the gentlemen whom he ſelected reſided in Edinburgh: it was then diſcontinued, as I think he told me, becauſe he did not continue a correſpondence with the academy, and communicate all the Britiſh improvements in marine education.

Much has been ſaid of profeſſor Robiſon's lectures on natural philoſophy; much that is true, and ſomething that is unqueſtionably falſe. It is univerſally admitted that he gives a comprehenſive and ſcientific view of his ſubject, and that he ſkilfully applies its principles to the arts of life; but complaints have been made of the abſtruſeneſs of his demonſtrations. Are the complainers certain that the demonſtrations are abſtruſe to ſuch as are qualified by a preparatory know-

* The ball-cock thus deſcribed was, in fact, the ſame with that of Deſaguliers, noticed in the article Water Works in the *Encyclopædia*. Dr. Robiſon, after expreſſing ſome ſurpriſe that the writer in the newſpaper ſhould have ſaid that it is not noticed in that article, gave me an account of his having been frequently employed to diſengage air from water pipes both in England and in Scotland; but ſaid nothing of his being ſo employed at St. Peterſburgh.

ledge

ledge of mathematics to enter upon the ſtudy of natural philoſophy? It becomes not me, perhaps, to anſwer this queſtion; but I may ſurely ſay that, in converſation, no man communicates knowledge more clearly than Dr. Robiſon, and that a more perſpicuous account of what philoſophy can attain, and how it ſhould be cultivated, will not readily be found than what he has given in the *Encyclopædia Britannica* under the titles Philoſophy and Phyſics. To underſtand the demonſtrations which he gives in the claſs, no higher knowledge is requiſite than that of the moſt elementary properties of the conic ſections; and, for my part, I cannot conceive how he, or any man, could demonſtrate that the moon, for inſtance, is retained in her orbit round the earth by a gravitation, ſuch as Newton diſcovered, to him who knows not the nature of the ellipſe which ſhe deſcribes.

Of the eſtimation in which his talents and his virtues have been held, not only by his colleagues in the univerſity of Edinburgh, but by various other literary ſocieties, the following unſolicited honours conferred upon him by thoſe ſocieties, afford ample evidence.

In 1783, when the Royal Society of Edinburgh was incorporated by charter, he was unanimouſly choſen general ſecretary; and diſcharged the duties of the office to the ſatisfaction of the preſident, vice-preſidents, and council, till a few years ago, that bad health obliged him to reſign it. In 1798 he was complimented with the diploma of LL.D. by the academy of New Jerſey. In 1799 he was created LL.D. by the univerſity of Glaſgow, which ſent to him a diploma conceived in terms the moſt honourable, as well to the ſenate that decreed it, as to him in whoſe favour the decree was paſſed. And in 1800 he was unanimouſly elected foreign member of the Imperial Academy of Sciences of St. Peterſburgh, in the room of Dr. Black. To the ſcientific public it may not be unacceptable to add, that, at the particular requeſt of the friends of that eminent chemiſt, he is now preparing his lectures for the preſs.

Though this detail muſt not be conſidered as a ſpecimen of biography, but merely as correct annals of Dr. Robiſon's life, it would be unpardonable to conclude it without noticing his connection with the fraternity of Free-maſons, and his attack on their higher myſteries.

As I was privy to the compoſition of his Proofs of a Conſpiracy, &c. I have his own authority to ſay that he never was in a maſon lodge in Great Britain. Once, indeed, when a lad at college, he was carried into a barn by two or three of his companions, who, being themſelves free-maſons, ſhowed him,

him, in a frolic, ſome mummeries, exacted his oath of ſecrecy, and told him that he was now a free-maſon! The whole appeared ſo ſilly that he believed they were playing a trick upon him. This was, indeed, the caſe; but the ſcene gave him ſuch an idea of maſonry, that he never beſtowed a thought upon it till he was at Liege in his way to St. Peterſburgh. Dining one day with ſir Charles Knowles at the table of the prince biſhop, he was ſurpriſed to obſerve that all preſent, maſters and ſervants, had about them ſome badge or other of free-maſonry; and learning that the chapter conſtituted a lodge, of which the biſhop was the *très-vénérable*, he was eaſily perſuaded by ſuch maſons to become a brother. He was accordingly received apprentice a few days after, and has himſelf publiſhed an account of his progreſs through the other degrees till he attained the rank of Scotch maſter. In all the converſations which I have had with Dr. Robiſon on this ſubject, juſtice requires me to ſay that I never heard him once inſinuate that there is any thing immoral in the ſimple ſyſtem of Britiſh maſonry; and he certainly has not accuſed that ſyſtem of immorality in his book. Yet I have heard Britiſh maſons apply to themſelves all that he hath ſaid of the French degrees, and even of the order of the *Illuminati*, and repreſent his Proofs of a Conſpiracy as a collection of calumnies! Surely ſuch men are not aware that, by holding this language, they accuſe themſelves of crimes of which the author of the Proofs has declared them innocent. I can, however, aſſure them that he conſiders their myſteries as extremely frivolous, though not criminal; and that, on account of the ſuperſtructure which elſewhere has been raiſed on them, he never adviſes a young man to become a free-maſon.

Dr. Robiſon retains an affectionate attachment to the place of his nativity, and paſſes a part of every ſummer amid the ſcenes of his youthful pleaſures. What he poſſeſſes is but a remnant of the eſtate which was the property of his father; but he is a man of too much virtue to diminiſh it otherwiſe than as it was diminiſhed before—in making proviſion for his children; and too much addicted to ſcience and literature to ſet his heart anxiouſly on increaſing it.

Nam ſapiens virtuti honorem, præmium, haud prædam petit.

LXVI. *Extracts from Foreign Journals reſpecting the Hiſtory and Antiquity of the Cow-Pock, and the Progreſs of the Vaccine Inoculation.*

IF the moſt glaring inſtance were required of the very long overſight of men to a ſimple fact of obvious application

tion to a practice of infinite moment to the comfort of the whole human race, one might name with truth the inoculation of the vaccine diſeaſe. When we read, in the work noticed in our laſt Number, the accounts of the fact of the cow-pock being known among the country people, not only in England, but in Ireland and Germany; and even ſome inſtances of intentional inoculation, we felt humiliation from the notion of the human intellect excited on this occaſion. Although, with partiality to our own countrymen, we may even rejoice to find, in the extracts before us, inſtances of equally glaring overſight in other nations; yet theſe further inſtances, we muſt allow, afford confirmation of the humiliating notion juſt mentioned.

I. *On the Antiquity of the Cow-Pock, and of its Inoculation Time immemorial in Germany.* (*From Annalen der Kuhpocken-Impfung.*)

(No. 2. page 135.) Buckburg, Feb. 25, 1802.

"The following highly important document, and hitherto the oldeſt known in regard to the hiſtory of the cow-pock, will, no doubt, be welcome to our readers, and particularly to the friends of vaccination.

"A weekly journal, entitled *Allgemeine Unterhaltungen*, for the year 1769, printed at Gottingen by F. A. Roſenbuſch, with plates, contains a learned diſſertation, by a writer who calls himſelf 'An old houſekeeper,' without mentioning the place of his abode, 'on the diſeaſe among the horned cattle; of quotations from Livy;' the moſt remarkable paſſage in which is to the following purport: 'On this ſubject, however, I will not venture to decide; but what chiefly excites my attention, is the circumſtance that ſuch a plague was very *common among men and theſe animals*, which is not the caſe at preſent. I conceived that there might be many diſeaſes of this kind, and that perhaps it was only ſome inflammatory fever, accompanied with eruption, which was often common to men and animals; and Livy, in one place, calls it expreſsly *ſcabies*. But it afterwards occurred to me that it might be the well-known cow-pock, not unknown in this country, (Gottingen, no doubt, where the journal was printed,) and which is ſtill infectious to the girls who milk cows, and to other perſons who have the care of theſe animals. It is true, indeed, that few men or animals die of this diſeaſe; but thoſe attacked by it may be exceedingly ſick, and perhaps it is owing to the coldneſs of our climate that the poiſon is not more violent. I muſt, however, remark, that in this country (Gottingen) thoſe

those who have had the cow-pock are fully convinced that *they are secured from the infection of the common small-pox, as I myself, on carefully inquiring into this circumstance, have often heard.*'

"This remarkable document was discovered and again made known by Mr C. G Steinbeck, who, as I learn by a letter from a friend, inserted it in his monthly journal, called The German Patriot, for January 1802. When the person who transmitted this notice, counsellor Faust, found it among his books, he exclaimed, *Evρηκα*! I have found it! Hanover or Germany, therefore, enjoys the honour of having first discovered and publicly described the cow-pock, and the virtue it possesses, as far as is yet known, of being a preventive of the small pox *."

(No. 1. page 86.) "In the month of July, 1800, the cow-pock was discovered among the cows in the neighbourhood of Plön, and a physician of Eutin made experiments with the matter, an account of which may be seen in Henning's *Genius der Zeit*, for the month of October, 1800. 'Just when I was about to send the copy of these annals to the press,' says the author, 'I read in the *Reichs-Anzeiger*, 1801, No. 182, a piece of very important intelligence, by counsellor Heilwag of Eutin, that in Holstein and Jutland there are several men who have had the cow-pock, which is indigenous in that country, both by infection and by being purposely inoculated, 13, 29, 36, and even 46 years ago, and who have been hitherto preserved from the infection of the small-pox, though attempts have been made to communicate the latter disease to them by inoculation.'"

(No. 2. p. 110.) "A malignant species of the small-pox, which, about the time when the first experiments were made in Germany, prevailed for fifteen months in the neighbourhood of Hanover, and swept off a great many children, contributed not a little to favour the introduction and propagation of the vaccine inoculation.

"Matter was immediately procured from Dr. Jenner in Gloucestershire, and it was observed that it produced more local effect on the place of inoculation, while that obtained from Dr. Pearson of London often produced a mild eruption. The same thing was afterwards observed in regard to the cow-pock matter produced in Hanover. At first it was supposed that this difference in effect arose from a difference in the inoculating matter. But Dr. Pearson, who was con-

* Is it too very singular that no physician of Gottingen, or of Germany in general, had it been only in consequence of this Essay of the year 1769, thought this circumstance worthy of further examination?

sulted

sulted on this occasion, informed Stromeyer*, in a letter, that he considered the difference which had been observed as merely accidental, and not as depending on the difference of the matter. Even experience shows, that in regard to the principal object, the property of preventing the small-pox infection, the vaccine matter of doctors Jenner and Pearson, and that produced in Hanover, are entirely the same."

(No. 2. p. 126.) "That the cow-pock does not infect, but by the immediate contact of wounded places, has been confirmed by experience in Hanover; as has also been the assertion of Dr. Pearson, that those who have once had the common small-pox, or the genuine cow-pock, cannot be affected a second time by either of these diseases, even though the vaccination be several times repeated. In the last case, however, suppurating pustules, surrounded with a little redness, arise sometimes from the puncture; but they are not only unattended with the characteristic form of the real cow-pock pustules, but the general re-action on the system connected with it."

II. *Cow-pock introduced into Portugal.* (From the Lisbon Gazette of 31st July, 1802.)

"Doctor Francis Manuel da Paula, approved physician, &c. having applied himself successfully to the vaccine inoculation, makes known to the public, that he is provided with matter of the best quality for inoculation from England, by means of Dr. Domeir †, who first propagated the disorder before he left this country. The above physician Da Paula has continued the inoculation from children of three months old and upwards, among which number were his own children."

III. *Discovery of Vaccine-Pox among the American Cows.* (From the American Medical Repository, vol. v. p. 93. 1801.)

"We are happy to find that our suggestion to physicians in the United States, to inquire for the vaccine disease among the cows of this country (see our vol. iv. p. 322), has produced the desired effect. The coincidence of the following articles of information, derived from different respect-

* Neues Hannovr. Magazin 1800, and Hufeland's Journal der Prakt Heilk, v. 10. part 3.

† Dr. Domeir is the attending and travelling physician of his royal highness the duke of Suffex; and after great difficulties were overcome, and bestowing much pains, he introduced the cow-pock inoculation with matter furnished from the Vaccine Institution of London.

able

able sources, and, so far we know, without communication with one another, seems to place the fact beyond the reach of doubt. We state them as they severally came to our hands.

"1. Dr. William Buet, of Sheffield, in the state of Massachusetts, in a letter to Dr. Miller, dated 20th May, 1801, describes the case of a lad, in his neighbourhood, affected with an eruption on his face and hands, greatly resembling vaccine pustules, to whom he was called on the 10th of the preceding month. With matter taken from these pustules he inoculated several persons, and observed the disease to pursue a similar course, and to exhibit similar phænomena, to a case of actual vaccine-pox then under his care. And after the termination of this new disease, he tested it, as usual, by variolous inoculation, with the same happy result as in other cases of the vaccine-pox. Upon inquiry, he found the lad had sometimes milked cows, that these cows had been observed to have sore teats, and that the hands and face of the lad had been prepared for the reception of the disease, by having been previously scratched in play by his companions.

"2. Dr. Elisha North, of Goshen, in the state of Connecticut, who has bestowed much attention on the vaccine disease, has found it among the cows of that neighbourhood, and inoculated it with success. In a letter of the 25th of May last to Dr. Miller, he announces the discovery, and that the inoculation of the disease had been tried in a number of instances with complete effect.

"3. Dr. Joseph Trowbridge, of Danbury, in the state of Connecticut, in a letter to Dr. Mitchill, dated 6th of July, 1801, communicates a similar discovery which he has made among the cows of that place. At that time he had inoculated three persons of his own family, and the disease produced by the inoculation exhibited all the appearances of the genuine vaccine-pox.

"Since our last Number, the vaccine disease, apparently genuine, has been introduced and propagated in this city (New-York). The present season of the year, which, according to popular prejudice, is deemed unfavourable to inoculation, has hitherto prevented the disease from being employed frequently or generally: and the usual banishment of the small-pox at this time renders it more difficult to apply as a test of the genuineness of the few cases of vaccine-pox which have yet occurred. We hope to be able to offer a more satisfactory account of the progress of the disease in our next Number."

The

The above account affords another proof of the little dependence to be placed upon phyficians in the application of facts to practice; and the more glaring they are, it feems, the more heedlefs, or even ftupid, they have been in fome inftances, as in the prefent cafe. It now appears that the cow-pox prevails not only in the weftern counties of England, where the farmers difcovered that their fervants or themfelves were exempted from the fmall-pox by having had the cow-pox; but the fame difeafe and the fame fact of exemption were alfo known in other Englifh counties; in Ireland, in Holftein, in Denmark, in many parts of Germany, and even near Gottingen, in Switzerland, and in the Milanefe. Nay, as long ago as 1769, the German journalifts announced thefe facts, and the advantages over the fmall-pox.

LXVII. *Some curious Obfervations refpecting the Crocodile. By* C. FRANK, *Phyfician to the French Army of the Eaft.*

WHEN Egypt and the Nile become the fubject of converfation in Europe, the danger to which people are expofed of being devoured by the crocodile is commonly mentioned. It is, however, not generally known that this amphibious animal is never feen in that part of the Nile which traverfes Lower Egypt, and that to obtain a fight of this monfter it is neceffary to go up the river a confiderable way into the Thebaide. I never found any crocodiles till I had got a good way beyond Gyrge. This animal quits its retreats at the bottom of the water during the warm days, and when the Nile is low, and places itfelf on the fand-banks, which are then frequently met with. It was in the months of April and May that I travelled in the Said. The crocodile feldom appears on the banks of the river, except when little frequented, or when acceſs to them is difficult. It appears that the crocodile is aware of the danger to which it would be expofed without that precaution. In general, it never goes to a greater diftance from the water than about fix paces. The leaft noife awakens it. I never was able to get within mufket fhot of it. Befides, as the animal is covered with very hard fcales, it is almoft impoffible to kill it, unlefs it be wounded exactly under one of the fhoulders. I found at Dendera a *kachef* who took a fingular delight in hunting the crocodile; he had killed, in fucceffion, feven of them, which I faw placed on the terrace of his houfe in fuch a manner, that at fome diftance they refembled fo many cannon. If the natives

ſhoot any of them, or catch them in ſnares, they are as proud as thoſe who, in Europe, kill a wolf. Of all the crocodiles which I had an opportunity of ſeeing, either in going up or down the Nile, I never obſerved any more than eight or ten feet in length. Proſper Alpinus ſpeaks of a crocodile thirty ells in length: but it is proper to remark that this author never was in Upper Egypt, and that he was probably deceived by falſe reports. The celebrated Norden ſays he ſaw ſome fifty feet in length. I am, however, of opinion that he was deceived alſo; for I never found any perſon in the country who ſaw any ſo large.

In regard to the danger of being devoured by this animal, it is much leſs than is commonly believed. The crocodile, in general, ſeems to dread man, for it is not fond of inhabited places: the nearer, then, that one approaches to the cataracts, the more frequently they are met with. The indifference with which the inhabitants and their children amuſe themſelves in the water and walk on the banks, proves to me that they are in no dread of the crocodile.

If a favourable opportunity, however, occurs, this cunning animal will ſeize a ſheep, a goat, or an aſs, and ſometimes a child, which it drags with it to the middle of the river, and plunges to the bottom. In one place, where the women are accuſtomed to fill their veſſels with water, I ſaw a ſemi-circular paliſade, made of reeds, deſtined to prevent the crocodile from doing miſchief. In that place, one of them ſeized and tore off a woman's breaſt at the time ſhe was ſtooping down to fill her pitcher with water.

It is a very ſingular obſervation, that this animal when it remains out of the water is almoſt always ſurrounded by various large birds, among which I could always diſtinguiſh the pelican. What ſtrange relation exiſts between theſe animals ſo different? It is a well-known fact, that the white heron has a ſingular ſympathy for the buffaloes, oxen, and cows. Does there exiſt a ſympathy of the ſame kind between theſe birds, but particularly the pelican and the crocodile?

LXVIII. *Proceedings of Learned Societies.*

FRENCH NATIONAL INSTITUTE.

ACCOUNT of the labours of the Claſs of the Mathematical and Phyſical Sciences during the third quarter of the year 10.—Continued from p. 300.

C. Denieuport, aſſociate, has ſent to the claſs a memoir concerning the equilibrium of a body which balances freely

on a flexible wire or fluid. He determines, in a ſpecial manner, the conditions of this equilibrium from this principle, that the centre of gravity of the ſyſtem muſt deſcend as low as poſſible; and details various ſituations of equilibrium, either fixed or tranſitive, which the propoſed bodies may aſſume.

EXPERIMENTAL PHILOSOPHY.—*Determination of the Intenſity of the Action which Magnetic Bars exerciſe on different Metals purified by the ordinary Proceſſes.*

In purſuing his reſearches on the action which magnetic bars exerciſe on all bodies, C. Coulomb has been able to meaſure the intenſity of this action for the different metals brought to that ſtate of purity which reſults from the common operations of refining.

He formed ſmall cylinders of wax, into which he introduced different quantities of iron-filings uniformly diſperſed over the whole maſs, and, by meaſuring the action which they experienced from magnetic bars, has deduced the law according to which the magnetic force decreaſes in proportion as the quantitity of the iron mixed is leſſened. With theſe two data he determined the very ſmall quantity of iron that remained in an ingot of ſilver fuſed with an equal portion of iron by C. Guyton, and which in the operation had appeared to ſeparate itſelf very exactly from the ſecond metal.

This ſilver, diſſolved in nitric acid and precipitated by pruſſiate of ſoda, gave no indication of the preſence of iron; it however experienced, in a ſenſible manner, the influence of the magnetic bar, and in ſuch a manner as to ſhow that it ſtill contained iron. By comparing this action with that of the ſame bar on the cylinders above mentioned, C. Coulomb has found that there remained in the piece of ſilver $\frac{1}{\text{?}}$ of iron. He found by the ſame method, that if the action of the magnetic bar on a plate of ſilver purified by cupellation, or extracted from the muriate, ought to be aſcribed to the preſence of iron, the quantity of the latter metal preſent will amount only to $\frac{1}{\text{?}}$ part. This quantity, which may be conſidered as infinitely ſmall, would, however, be in ſuch a ſtate of diviſion that there would be no molecule of ſilver which did not contain a portion of iron.

On the 11th of Pluvioſe C. Guay Luſſac preſented to the Inſtitute a memoir on the dilatation of various elaſtic fluids by the agency of heat. In examining the experiments of different philoſophers on this ſubject, he ſtates that the great diſcordancy in their reſults is chiefly owing to the preſence of water in the apparatus employed, which being diſſolved by

the gas employed, or converted into vapour in it, in different proportions at different temperatures, causes it to undergo irregular expansions. By the methods that he employed, the vessels and instruments made use of were rendered completely dry; and under these circumstances he found that the volumes of all the permanent elastic fluids, whether soluble or insoluble in water, underwent an uniform and equal change of volume with every change of their temperature; and that they suffered an expansion of $\frac{1}{180}$ of their bulk in passing from the temperature of 32° Fahrenheit to 212°. The vapour of ether obtained by heat followed the same law of equable dilatation; and calculating upon it, it appears, that with every increment of a degree of Fahrenheit there is an increment of volume of nearly $\frac{1}{571}$, probably, for all aëriform fluids. This is not very different from the estimation given in his *Trait Elément ire de Chimie*, by Mr. Lavoisier, who, from the experiments of Mr. de Luc, considers the expansion of atmospherical air as $\frac{1}{475\frac{1}{2}\frac{1}{0}\frac{1}{5}}$ for each degree of Fahrenheit *.

LXIX. *Intelligence and Miscellaneous Articles.*

VACCINE INOCULATION.

THE printed report of the house of commons professing merely to have published extracts from the minutes of the evidences, but a partial account only having been given to the public of Dr. Pearson's evidence from those minutes, we propose to give it wholly. It is not our intention to make any remarks; the fairest way for the parties interested, and most proper conduct for us, being considered to be the giving the account from the minutes, especially as Dr. Pearson's "Examination of the Claims†," &c. just published, is most likely to afford the requisite explanations.

In our next Number we shall give the second and only other evidence of Dr. Pearson on the 15th of April.

Dr. Pearson's first Examination (the honourable admiral Berkeley in the chair), agreeably to the Summons dated Lunæ, 5to Die Aprilis 1802. [From a Transcript by the Committee Clerk, taken from the Minutes of the House of Commons.]

Are you conversant with the vaccine inoculation?

* On this article the editors of the *Journal des Mines* remark that, according to the experiments of Mr. Saussure, air, in all its different states of saturation with moisture, experiences uniform increments of temperature; and that of some experiments from Amontons it is proved that the principle is the same with regard to pressure.—EDITOR.

† See our last Number, page 283, for the account of this publication.

A. Yes: I have been acquainted with the practice ſince January 1799. I alſo think it is but juſtice to Dr. Jenner to ſtate, that I am acquainted with the practice of inoculation of perſons for the ſmall-pox, who on good evidence were ſaid to have gone through the cow-pox ſince June 1798: the reſult of which was, that they could not receive the ſmall-pox infection.

Was it from the communications of Dr. Jenner, or any other ſource, that you derived your knowledge of the vaccine inoculation?

A. In the firſt inſtance from Dr. Jenner: afterwards I got information from other ſources.—[Letters delivered in.]

Do you imagine that the information contained in theſe letters aroſe from Dr. Jenner's publication of his diſcovery, or from a previous knowledge of vaccine inoculation?

A. I imagine they were independent of each other.

Did you ever hear that Dr. Jenner had communicated his diſcovery to Mr. John Hunter many years previous to this correſpondence? And is it not known that in his lectures ſome years before his death he mentioned it publicly?

A. Not *the practice of inoculation*; but that Dr. Jenner had acquainted him that perſons who had the cow-pox could not take the ſmall pox, and that nobody had been known to die of the cow-pox.

Had you any other communications with the Rev. Herman Drew, beſides the letters delivered in, upon the ſubject of vaccine inoculation?

A. None that I think relate to the queſtion.

Does Mr. H. Drew lay claim to the diſcovery of inoculating with the vaccine matter from one human being to another?

A. No; that is excluſively* Dr. Jenner's.

Do you know when the facts ſtated in the correſpondence which you delivered to the committee actually took place†?

A. Only that they took place, in all probability, earlier than the year 1798.

On what do you ground that opinion?

A. Becauſe, immediately upon the publication of Dr. Jenner's work in 1798, I wrote to the gentlemen who furniſhed that information, namely, the Rev. Mr. H. Drew, Dr. Pulteney,

* Dr. Pearſon, in his book lately publiſhed, finds that this is not ſtrictly correct; for vaccine inoculation from the human ſubject had been previouſly inſtituted.

† The dates were ſubſequently obtained, and are printed in Dr. Pearſon's work juſt publiſhed.

Mr. Dolling, and Mr. Down, of Bridport. They *immediately communicated their caſes of vaccine inoculation, without appearing to be acquainted with Dr. Jenner's works.*

Have you reaſon to think that Dr. Jenner, previous to the publication of his firſt work on vaccine inoculation, was at all acquainted with the facts contained in the correſpondence delivered in?

A. I have ſaid, I apprehend the parties all performed their inoculations independent of each other.—Withdrew.

THE LONGITUDE.

The following letter from a gentleman in Greenock relates to a matter of ſo much moment, that our readers will regret the death of the perſon who contrived and executed the inſtrument alluded to. It is fortunate however that the apparatus is ſtill in exiſtence, as further experiments, and a more minute examination of its ſtructure, may perhaps lead to a diſcovery of its principles.

All that can be inferred at preſent is, that poſſibly a well poiſed magnetic ball, though it may remain ſtationary (excepting the change occaſioned by the magnetic variation), while kept in the ſame place, may poſſeſs a property which, on carrying it eaſtward or weſtward from that ſpot, may occaſion a revolution on its axis proportioned to the diſtance. Should any thing like this turn out to be the fact, we may yet ſee that accompliſhed which has hitherto baffled every human effort.

But be that as it may, ingenious men will endeavour to profit by the hint which the following letter preſents:

"Greenock, Aug. 2.

"An affair of ſo much conſequence to mankind as the following it were criminal in me to conceal; I therefore requeſt of you to make it as public as poſſible among your ſeafaring and philoſophical friends.

"Our mutual friend, before his departure laſt fall for Philadelphia, conſtructed a machine, apparently ſimple, but which is infinitely more valuable to navigation than the compaſs. It was brought to me, together with his log-book, by a fellow paſſenger homewards, who unluckily had paid no attention to the uſe of the apparatus; which was the more unfortunate, as our friend died within three leagues of land.

"It is a magnetic ball, floating in a baſon of quickſilver. The ball is painted all over, to keep the quickſilver from penetrating the pores, which might embarraſs the evolutions,

which coating I dare not deſtroy to examine the materials of the ball; but from its weight it muſt be metallic, yet it floats high in the fluid. Since he took it from this place, I perceive he has marked it with lines of longitude and latitude, like a geographical ſphere. This, I preſume, he has done on his voyage outward, the journal of which is likely left in America. But this which I poſſeſs begins with the exact point of latitude and longitude of Philadelphia, and records the zenith of every day as accurately as if he had been all along on terra firma. In bed he told the captain his diſtance from the coaſt of Ireland to a minute, by looking at his machine.

"The properties of magnetiſm are not yet ſufficiently known, and they have heretofore been applied to uſe only in the form of the needle. But it appears to poſſeſs, beſides its well known polarity, a propenſity to retain its native relative poſition on the earth; that is to ſay, it turns upon an axis, like the earth, one point always pointing at the pole ſtar. Beyond the line, this point upon the ball is below the horizon; and on the ſhores of America the longitudinal line, which now is its meridian, was far down the ſide: ſo that, if he had ſailed round the earth, his little ball would have made a complete revolution upon its axis."

ARTS.

We mentioned ſome time ago that a French artiſt had diſcovered a method of ſoldering glaſs when broken. This art we now underſtand has been carried ſo far towards perfection, that two plates of the ſize of eighteen inches may be joined together.

Another artiſt of the ſame country has found out the means of rolling plates of glaſs in ſuch a manner as to extend them ſome inches each time they are paſſed through the rollers, as would be the caſe with metal. The proceſs has not yet been made public; but we apprehend that a part of it muſt conſiſt in ſubjecting the plates, after the firſt caſting, to ſuch a heat as may make them ſufficiently plaſtic to go through the operation once, and ſo again for a ſecond and ſubſequent rollings, till the required extenſion be given to them.

The alloys of gold with platina have hitherto been ſuppoſed to depreciate the colour and malleability of the precious metal in ſuch a manner as to prohibit their uſe. It appears, however, from ſome late experiments made by an ingenious jeweller, Mr. Francillon, that a mixture, conſiſting of ſix parts of gold and one of malleable platina, gives a metal of

a beautiful colour, great malleability, and capable of receiving an exceeding fine polish, more unalterable than that of gold when exposed to the action of sulphurized hydrogen or similar agents.

A NEW COMET.

About ten at night, on the 28th of August, C. Mechain, member of the National Institute and of the Board of Longitude, discovered a new comet in the constellation of Serpentarius: it was some degrees below two nebulous stars which are on the left side of that figure, and near the equator. He determined its position, and found that it was rising with great rapidity towards the north. He continued to observe the following days. The light of this body did not appear to him to increase in a sensible manner; its nucleus did not become more brilliant; and the nebulosity which surrounded it did not extend.

On the 1st of September he made a report to the National Institute of his first and last observations.

August 28. Mean time, 9 hours $24' 6''$; right ascension, $249° 18'$; declination south, $6° 11' 31''$.

August 31. Mean time, 9 hours $35' 19''$; right ascension, $250° 16'$; declination south, $0° 29\frac{3}{4}'$. It is to be remarked, that, according to the present position of this comet, its distance from the sun is necessarily greater than that of the sun from the earth. It rises towards the north pole, following the left side of Serpentarius and the opposite side of Hercules. Though it is visible only with the help of telescopes, it may still be observed a long time if its light be not weakened.

We learn by a letter from Bremen, that on the 2d of September, at nine in the evening, Dr. Olbers discovered a small comet, which cannot be seen but with good telescopes. From its observed position it seems to be the same that C. Mechain saw six days before. Dr. Olbers' observations are stated as follows:

September 2, at one minute past eleven, its right ascension was $251° 28'$; declination north, $4° 32'$.

On the 4th, Mean time, 9 hours 7 min.; right ascension, $251° 28'$; declination north, $7° 57'$.

There is, however, probably, a mistake in the letter respecting the last-mentioned right ascension.

CHEMISTRY.

Mr. Arthur Aikin has succeeded in producing an amalgam of iron and mercury, by uniting an amalgam of zinc and mercury with iron filings, and then adding muriate of iron.

Fig. 1.

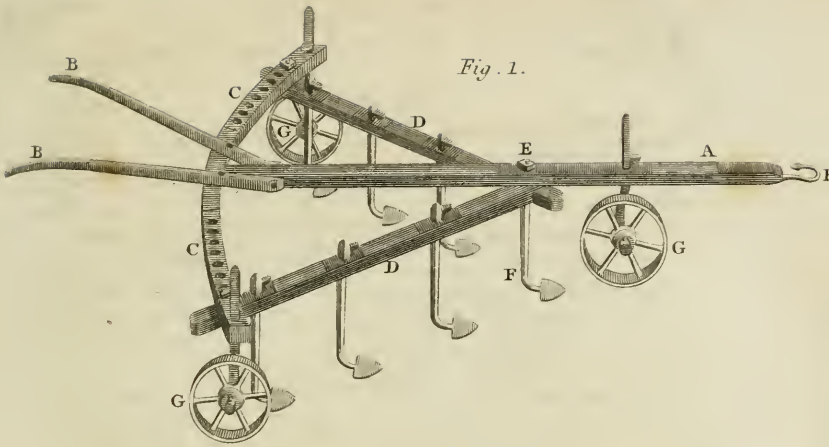
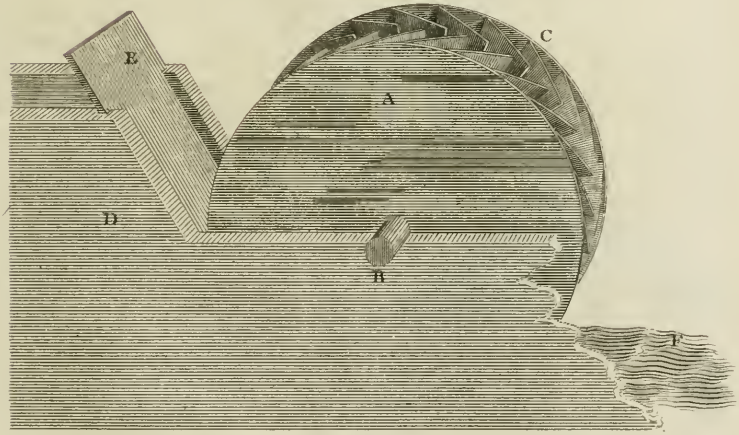


Fig. 2.



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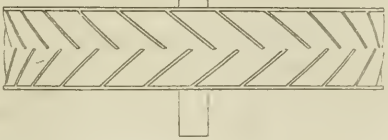
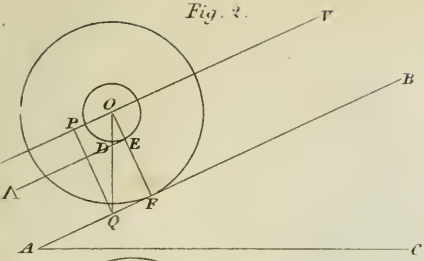


Lowry sculp

Fig. 2.



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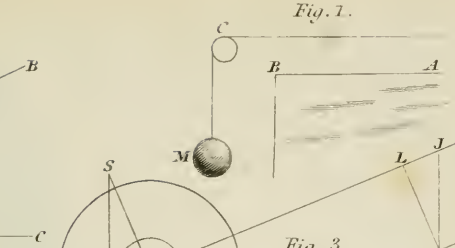

Fig. 3.

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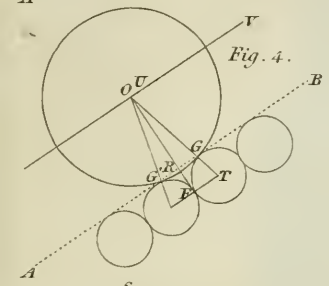

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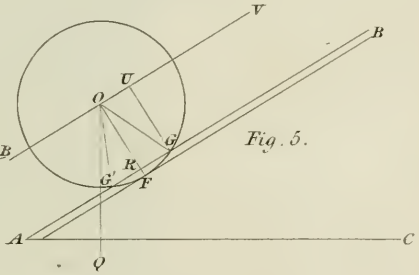

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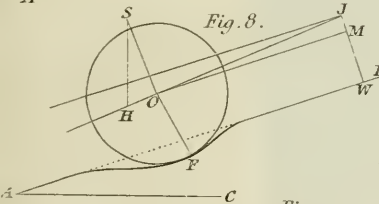

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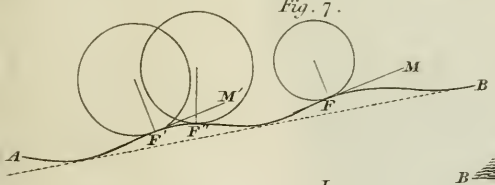

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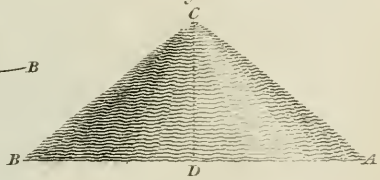

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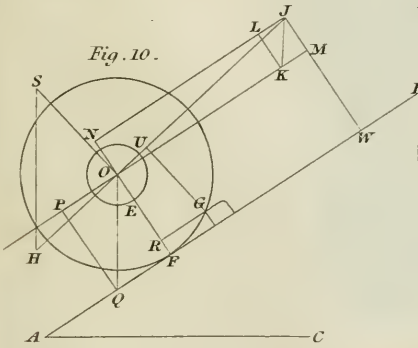

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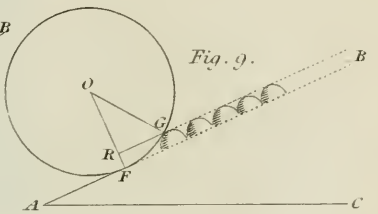
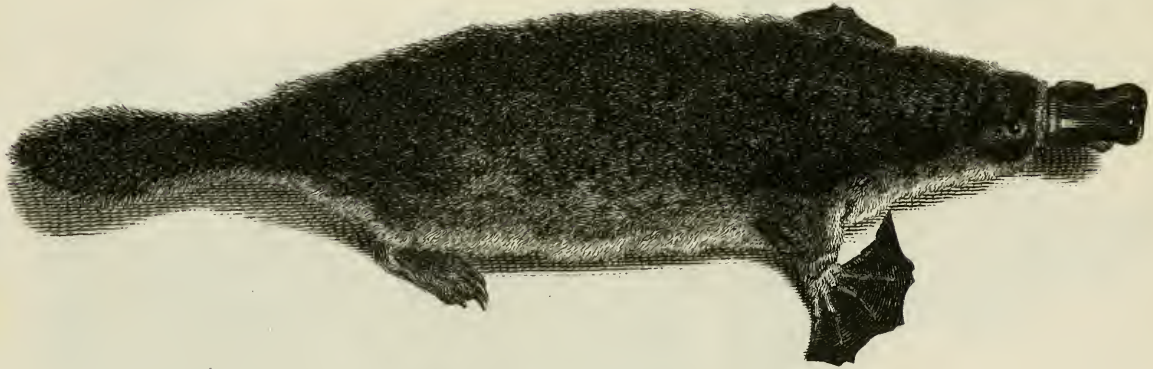


Lowry sculp.



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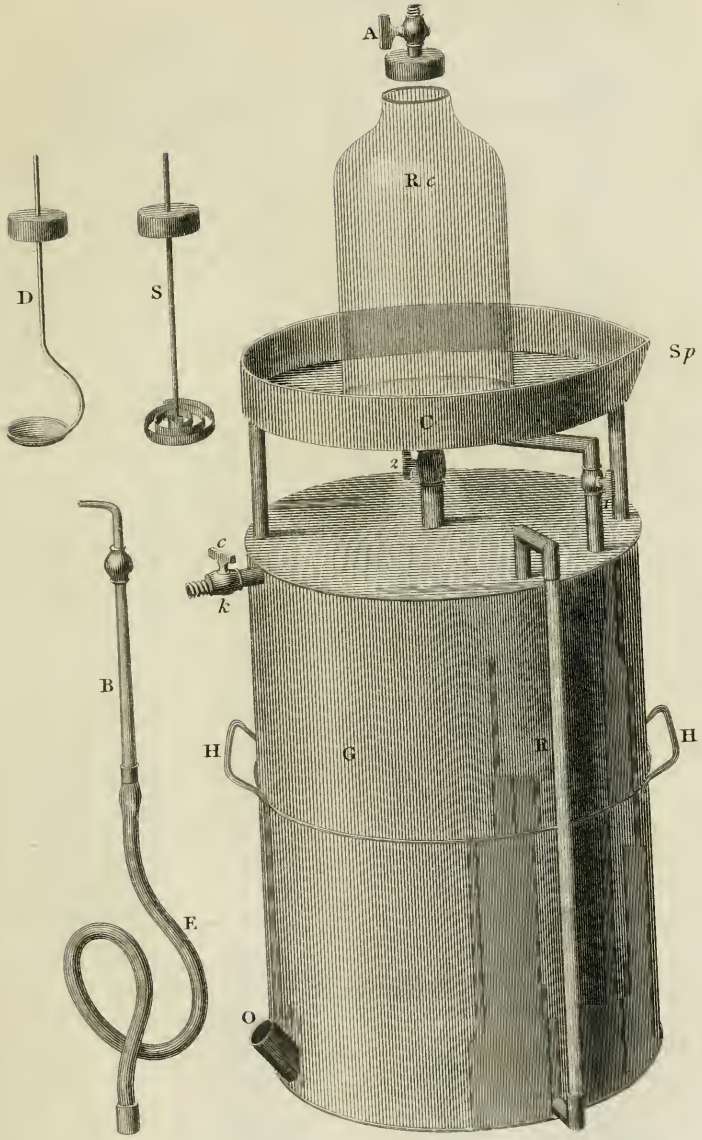
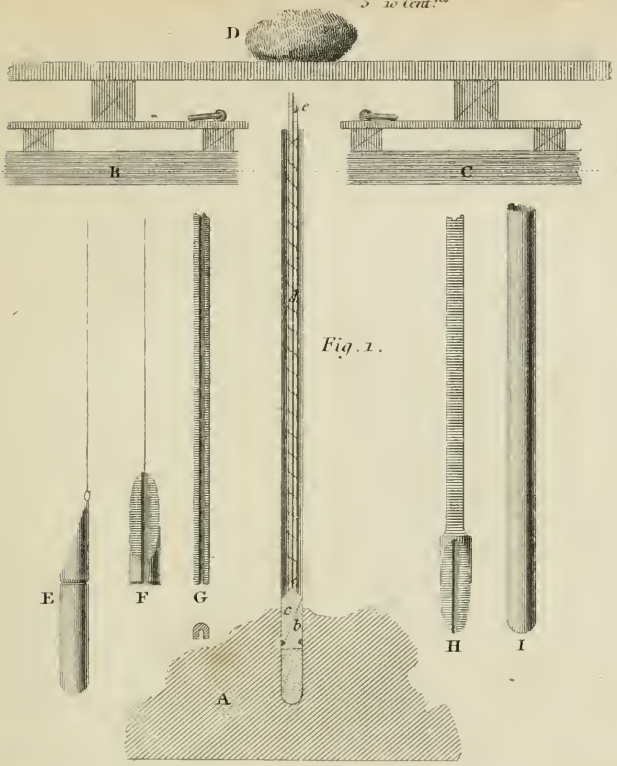


Lowry sculp

Scale of E.F.G.H.I. 1/5 to Cent. 1 2 3 4 5 Décimètres



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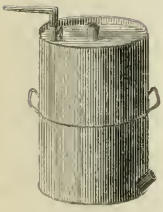

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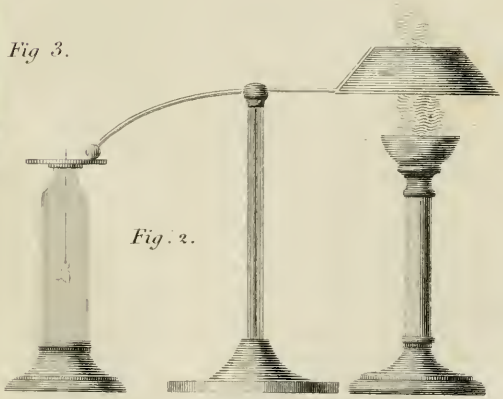
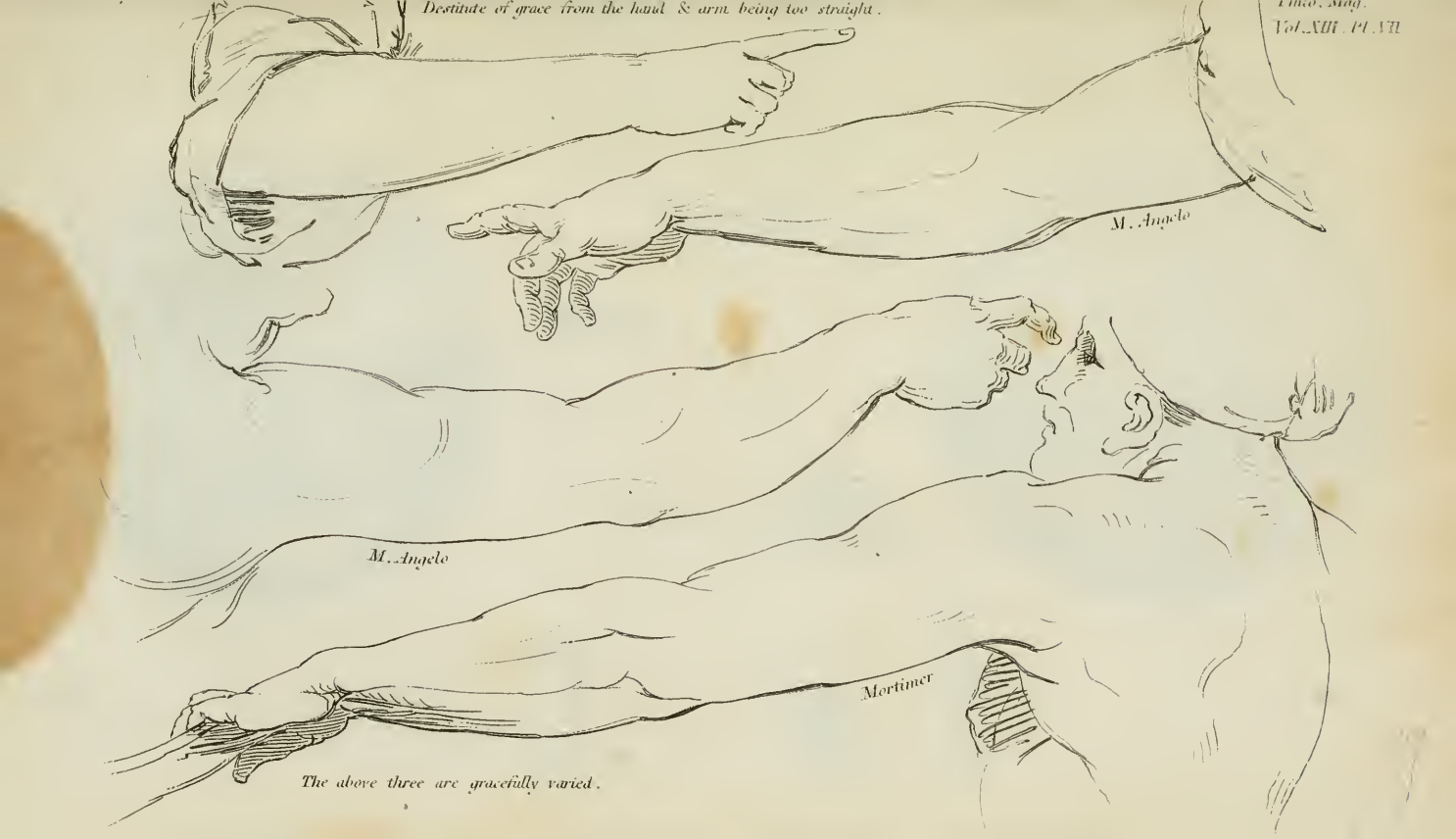


Fig. 2.

Scale of A.D. 5 Déc.s 1 Mètre

Lowry sculp.

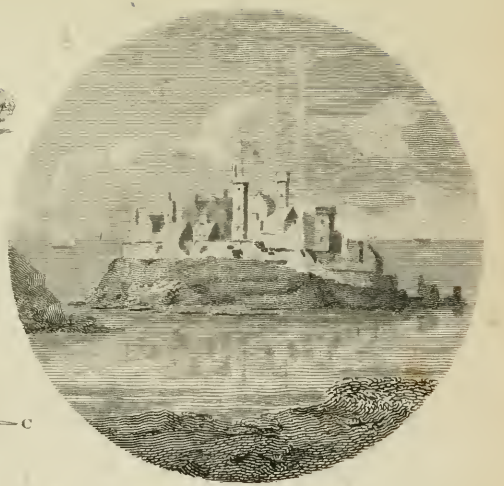
Examples of grace.


Destitute of grace from the hand & arm being too straight.
M. Angelo
M. Angelo
Mortimer
The above three are gracefully varied.

Seen Oct. 21st 1796.

Fig. 1.

Fig. 2.



Seen March 9th 1797.

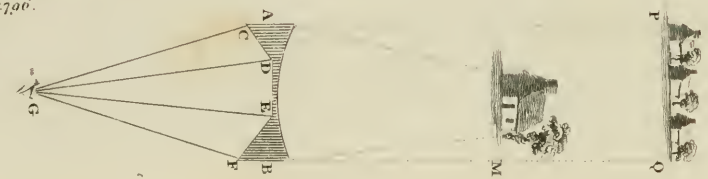


Fig. 3.

Lowry sculp.

iron. A decompoſition takes place, and there is produced a muriate of zinc and the amalgam of iron and mercury, which by kneading and the aid of heat aſſumes the metallic luſtre.

The ſame gentleman along with Mr. Allen has obtained a regulus of tungſten, from the ammoniate of that metal, the ſpecific gravity of which is above 17·22. It is of an iron colour and of great brilliancy, but not malleable.

MR. PEPYS'S GAS-HOLDER.

We find by a line from Mr. Pepys, that a note has been omitted in printing his article in No. 50. It related to the regiſter tube, and mentioned, that "it was added to the gas-holder on the ſuggeſtion of Dr. Marcet."

NATURAL HISTORY.

One of the French journals contains the following article:—"Snakes have increaſed this year ſo much in number in the large commons, that the proprietors of ſheep have ſuſtained great loſs by them. Theſe reptiles, particularly in the ſpring, ſuck the milk of the ſheep; and when the wound which they inflict is deep, the two teats dry up; ſo that the ſheep, which continue to be fruitful, can no longer ſuckle their young. But, when the wound is ſlight, the wounded teat only dries up. In ſeveral of the communes of the department of Landes, there are flocks, the ſheep of which have been ſucked by theſe ſnakes in the proportion of four to one."

NATURAL PHILOSOPHY.

Vaſſalli-Eandi, profeſſor of natural philoſophy in the Athenæum at Turin, has invented and cauſed to be conſtructed a pneumatic apparatus, with which all experiments in regard to the rarefaction and condenſation of air, and all kinds of aërial mixtures in given proportions, can be performed in an eaſy and ſimple manner by means of piſtons and cocks. This machine has been depoſited in the phyſical cabinet of Turin.

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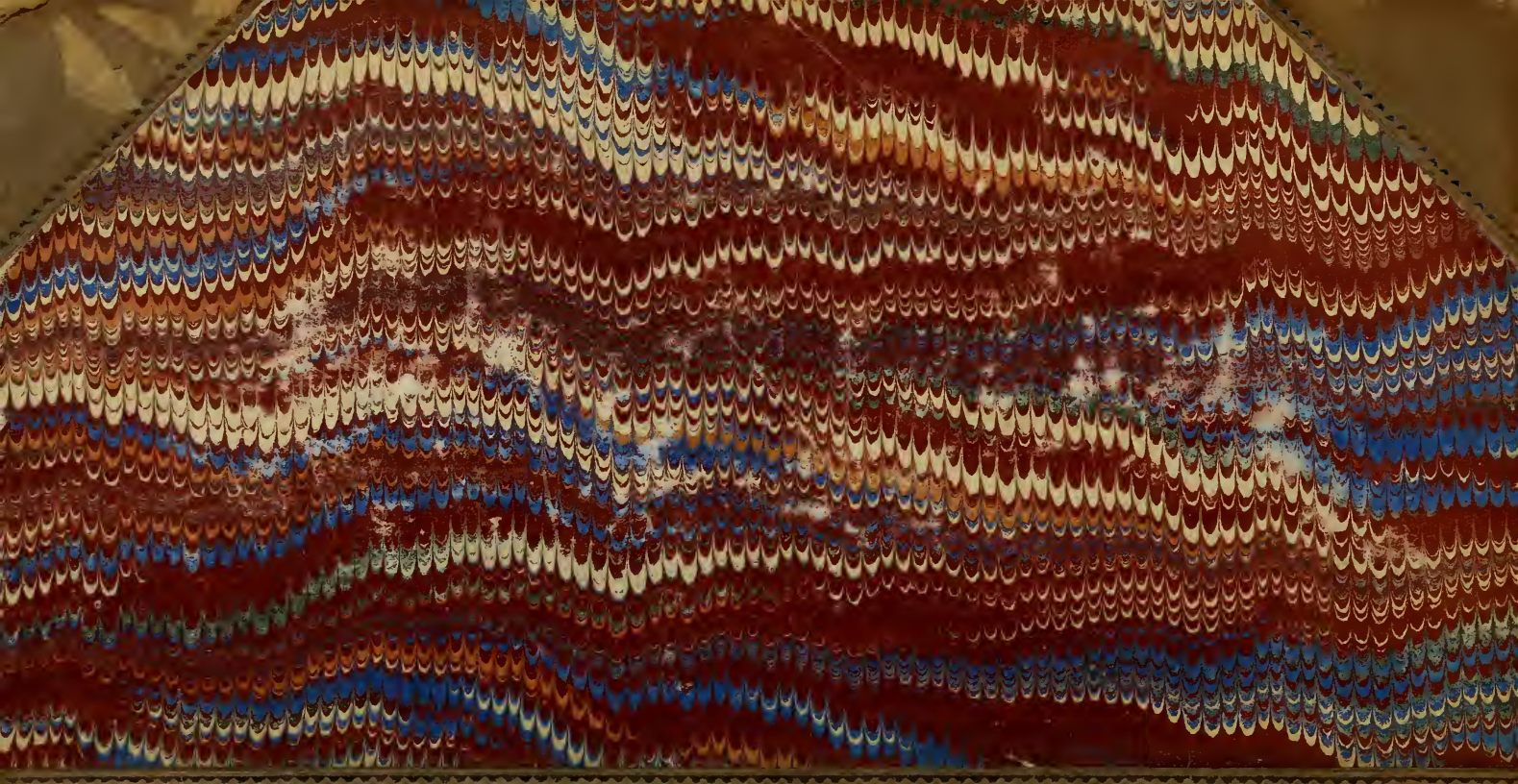
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